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J. A. BERLY'S

UNIVERSAL ELECTRICAL DIRECTORY

For 1893

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A REVIEW OF THE YEAR 1892.

THE year that has passed away has been, in some respects, a noteworthy one. It has been remarkable, chiefly, for the large number of working schemes which have been promulgated, and the few which have been carried out.

DEVELOPMENTS IN ELECTRIC LIGHTING AND TRACTION.

Important developments in electric lighting and transmission have been mostly in the direction of practical applications of well worked out and familiar systems. As was the case last year, a great number of corporations, local authorities and companies, have obtained provisional orders. Some, indeed, have proceeded to prepare a public supply of electricity, adopting either the low pressure continuous current system or the high pressure alternating and transformer system. Each system seems to find about equal favour among the experts called in to advise on the best system to adopt. We have much the same complaint to make this year as last about the nursing of provisional orders. True, large towns like Manchester, Huddersfield, Bristol, Dundee, and Nottingham, are actually engaged in the building of central stations, but the disposition towards *laisser faire*, if we may adopt the term, is still paramount. In no case in this country has any radically new system been adopted, but we may note that at Oxford a high pressure continuous current system, with motor-generator transformers, has been laid down and works successfully. The same system was also running with success during the Crystal Palace Exhibition, and now forms the system of supply for the neighbourhood. While Oxford leads with the continuous current motor generator system, Cambridge has adopted a high pressure alternating and transformer system, with Parsons's steam turbine. Both the use of continuous current motor generators in distributing electrical energy, and of high-speed frictionless engines at generating stations, are developments which no doubt will lead to some advantageous results.

During the past year no very great improvements in dynamos and lamps have been made. Electric motors have not been adopted as largely as might have been anticipated before the laying down of public supplies of electricity. The new device for inducing a larger consumption of electricity during the day-time for motive power, which has much to recommend it, has not succeeded up to the present. In this new scheme, it will be remembered that the electricity is to be sold during certain hours of the day at half price for motor work. The first example of the American overhead trolley-wire system of tramway car driving by electricity has been at work during the year at Roundhay, Leeds, and a case in the Law Courts is now *sub judice* concerning this method and its interferences with telephone work. The system of overhead traction adopted on the South Staffordshire Tramways has been lately commented on by us, but we cannot omit to

refer to this as a distinct advance in electric traction in England.

The alternating motor has developed chiefly in the direction of the reversed alternator working synchronously, but we still await the appearance of a self-starting and efficient motor for ordinary alternating circuits.

In the measurement of electricity supplied to the consumers, we have a subject of vast importance to the electrical industry at large, and to the electricity supply companies in particular; the construction of a meter, cheap, reliable, and capable of performing its work under the rough and ready conditions in which it may be placed, is no easy problem. During the past year much activity has been displayed in this direction but we must still look to the future for the results.

Last year opened with much interest in the "Drehstrom" system, rotary current system, or three-phase system. No development in this branch has been made in this country, although the subject is still being worked upon by German engineers. For the transmission of power to a distance by electricity it is no doubt the best system yet invented; there are no commutators on dynamo or motor, the currents are easily and effectually transformed from extremely high pressures to low pressures and *vice versâ*.

In alternating current work some interesting researches have been made with extremely high frequencies and high pressures, following on the lines laid down by Mr. Tesla in his famous lecture, but they have led us to no practical results so far as the developing of electric light and power are concerned.

In electro-chemistry there have been one or two important inventions, one of the most important being the introduction by Mr. Parker of the electrical method for producing phosphorus.

The Exhibition at the Crystal Palace was one of the features of the year, and the public were doubtless familiarised with many branches of the electrical industry. On the business side of the question, it is probable that the more general feeling is one of disappointment, but all exhibitors should remember that exhibiting is not an investment which leads to immediate returns. It is but the sowing of a seed which sometimes takes long to germinate, and a harvest may possibly be gathered at a later date. At any rate, the Exhibition was, on the whole, creditable to the industry, and should indirectly, if not directly, be of advantage to the exhibitors.

TELEPHONIC.

The measure providing for the purchase of the telephonic trunk lines by the Government, which received the Royal Assent at the end of the last Parliament, must, we presume, be regarded as the first step towards entire State management of the telephones. When the second or subsequent step is taken we may hope that it will be surrounded with greater public safeguards than the first. We protested strongly against the measure being so rapidly pushed through Parliament without opportunity being given to weigh the importance of the step and the probability that the expectations held out would be falsified. There was to be a plurality of Exchange Companies who would work most cordially with the Government and most strenuously against one another. The manner in which the measure has been turned to account in an exactly contrary manner was foreseen by us and perhaps would have occurred to some member of the committee also, if the governmental proposal had been pushed through with less haste and with more regard to the importance of the subject. Unless the inscrutable ways of diplomacy have been working in a direction foreseen and provided for to public advantage it must be admitted that so far appearances indicate that a measure ostensibly for the public benefit has only resulted in private gain. But no doubt when we are reviewing some future year we shall be able to comment upon the circumstances in the light of knowledge. At present it would appear that one set of circumstances was contemplated and another set has arisen.

In the practical working of telephony the most important event of the year is also connected with trunk lines. New York and Chicago, though separated by a thousand miles of the earth's surface, are united in speech by means of 2,000 miles of wire strung a few feet above the earth's surface. The addition of one more electric circuit between two such cities may seem a small matter; but, following the London-Paris line, it extends the practical limits of conversation to the longest distance yet attained, and its construction for the purpose of speech transference is a great advance made during the past year. As to the perfection of transmission contradictory accounts reach us, and perhaps there are variations which justify them all. But though the voice that is heard may be but "small," the voice is there, and, in itself, that is a notable achievement.

In another section of this article we have referred to an action, *sub judice*, which is as important from the telephonic as the electric traction view.

COMMERCIAL.

Apart from the scientific advances, there is to be considered the commercial side of electrical matters. During the past year we have probably heard more than ever before of competition, its keenness, its causes, and its cure. But we have not heard so much of its benefits. In all probability the sufferers by competition are more numerous than those who derive benefits from it, and that is why more is heard about it. In the benefits of competition honourably conducted all participate, but even the purchaser who obtains the only advantage in a game of cut and thrust between competitors, must eventually realise that his advantage is not long lived. There is a kind of competition which seeks to obtain business, not because it brings with it any material advantage, but because some other firm may be prevented from obtaining it. There is a kind of competition which seeks to make an appearance of business though no profit is involved. The close of the year has brought with it indications that competition to obtain work for outside show instead of for a reasonable profit is not only unfair competition but unprofitable competition, which brings with it a day of reckoning. Further, there is no doubt that firms who have built up a reputation have temporarily suffered from those who are in too great a hurry to build up a business. We say temporarily suffered, because again the past year has shown that the enterprise which is devoted to the making of a reputation in the briefest possible time, and doing the largest possible business with the smallest possible capital, leads to a reputation, but not a good one, and to a business, but not a lasting one. Lest we should be misunderstood, let us say that enterprise is to be encou-

raged by every means, but only the enterprise which is backed by judgment, and not that which does harm to one firm and gives no prospect of good to the other.

Of the businesses which are more or less electrical, and have been the subject of much unhealthy speculation, we are glad to see that there are indications of an apparent desire to see the end of the speculative era, and devote some attention to more legitimate work. Those who have undertaken it have our best wishes, and a hope that some measure of success may be theirs, but our fears are much the stronger. The old Adam is strong, and speculative mania is deeply rooted in some organisations. So long as any of the speculative element remains in the control of companies, it is pretty sure that commercial prospects must take a second place.

NEW TRACTION SCHEMES.

We will conclude this article by calling attention to a subject which is likely to be of the utmost importance, both from the industrial point of view, and from that of the general convenience of the public. Electric traction has received the approbation of Parliament; it was only the termination of a government's term of office which prevented some of the schemes from being proceeded with. There are no fewer than eight underground railways proposed, the motive power of which will be electricity. It is estimated that the total cost of these lines will be something like ten million pounds. London will be completely intersected by these railways, and if only a small number are carried out, the advantages to be derived will be enormous.

We may add that the prospects for 1893 seem good. The erection of central stations alone, which are contemplated this year, will be sufficient to give a remarkable impetus to the industry.

INTERNATIONAL OKONITE COMPANY.

THE adjourned meeting of this company is to be held on the 10th inst., when the directors expect to be in a position to make a more satisfactory statement to the shareholders. We hope they may be able to re-assure the shareholders as to their prospects; but it seems impossible that any hope can be held out that the expectations of the prospectus are likely to be realised. These were hopeless from the first. We showed on July 4th, 1890, that the businesses were being acquired at the rate of 12½ years' purchase, and intimated, as strongly as we could, that the prospectus, though skilfully baited, was impossible of fulfilment. A company which is over capitalised, and buys businesses at excessive valuations, may, with reasonable confidence, be expected to be indifferently managed when it gets to work for itself. The International Okonite Company is no exception. The directors' admissions of mismanagement here, and over-valuation there, are the necessary accompaniments of "promoter's companies." Shareholders who wait until their property is in a hopeless muddle before they take any interest in its affairs must expect to lose money. In commenting on last year's accounts, we advised the company to cut that part of the business which did not pay and devote their energies to that which did. A year ago some good might have been done. Now it would be more difficult. But there is apparently some business capable of being made a source of income. If the shareholders will go to work and organise their company so as to carry on its affairs with due regard to economy and profit, they may eventually obtain *some* return on their capital. As things are at present, it is unlikely that any return will be obtained, and the outcome will be a certain amount of discredit, of which genuine electrical investments will most unjustly have to bear a part. The shareholders of the International Okonite Company, and kindred concerns, may learn, and communicate their experience to others, that electrical investments do not differ from other investments in affording profitable employment to capital properly employed, and that 12½ years' purchase for an electrical business is as much a mistake as for any other business. Promoters know it, but it takes shareholders some time to find it out.

Electricity and Chemical Synthesis.

IN an account of a recent attempt by Raoul Pictet at a general method of chemical synthesis we note the following. Congealed sulphuric was strongly compressed into refrigerated caustic soda, the temperature being — 125° C. Two insulated wires were introduced into the refrigerating tank, between the ends of which the spark from a powerful Rhumkorff coil was passed. The frozen sulphuric acid conducted the spark very well and after a quarter of an hour's operation the reaction of the acid upon the alkali was effected in the tracks of the sparks, but without extending laterally. Similar experiments were tried with the electric spark on mixtures of frozen sulphuric acid with ammonia, sodium chloride, and calcium and sodium carbonates respectively, similar results being observed. Experiments with other frozen chemicals led to similar results also. This kind of reaction is termed by Pictet slow reaction, it is always produced below a certain limit of temperature which is special for the substances brought in contact. The electric spark seems to be the best excitant to provoke this kind of reaction.

The Pacific Ocean Cable.

ON other pages we give an extract from the last issue of *La Journal Telegraphique de Berne*, concerning the steps now being taken by a French company, towards the laying of a cable in the Pacific. This company, it will appear, is supported and assisted by the French Government and will be subsidised by the Governments of Queensland and New South Wales. There are some obvious inaccuracies in the general statements made in the *Journal Telegraphique*; for example, the English Admiralty have shown no opposition to the Pacific scheme, as unanimously advocated by the members of the colonial conference; they have simply treated the matter as one of no importance (with the exception of the work begun by the already overworked hydrographical department). It now appears that a work unanimously recommended to the attention of H. M. Government, by a representative assembly from all the colonies will be executed by a combination of the Governments of France, the United States of America, and the Hawaiian Islands, and that instead of being English from end to end, it will only satisfy the wishes of the colonial conference as far as Fiji is concerned.

THE SUPPLY OF ELECTRICITY IN LIVERPOOL.

INTRODUCTION.

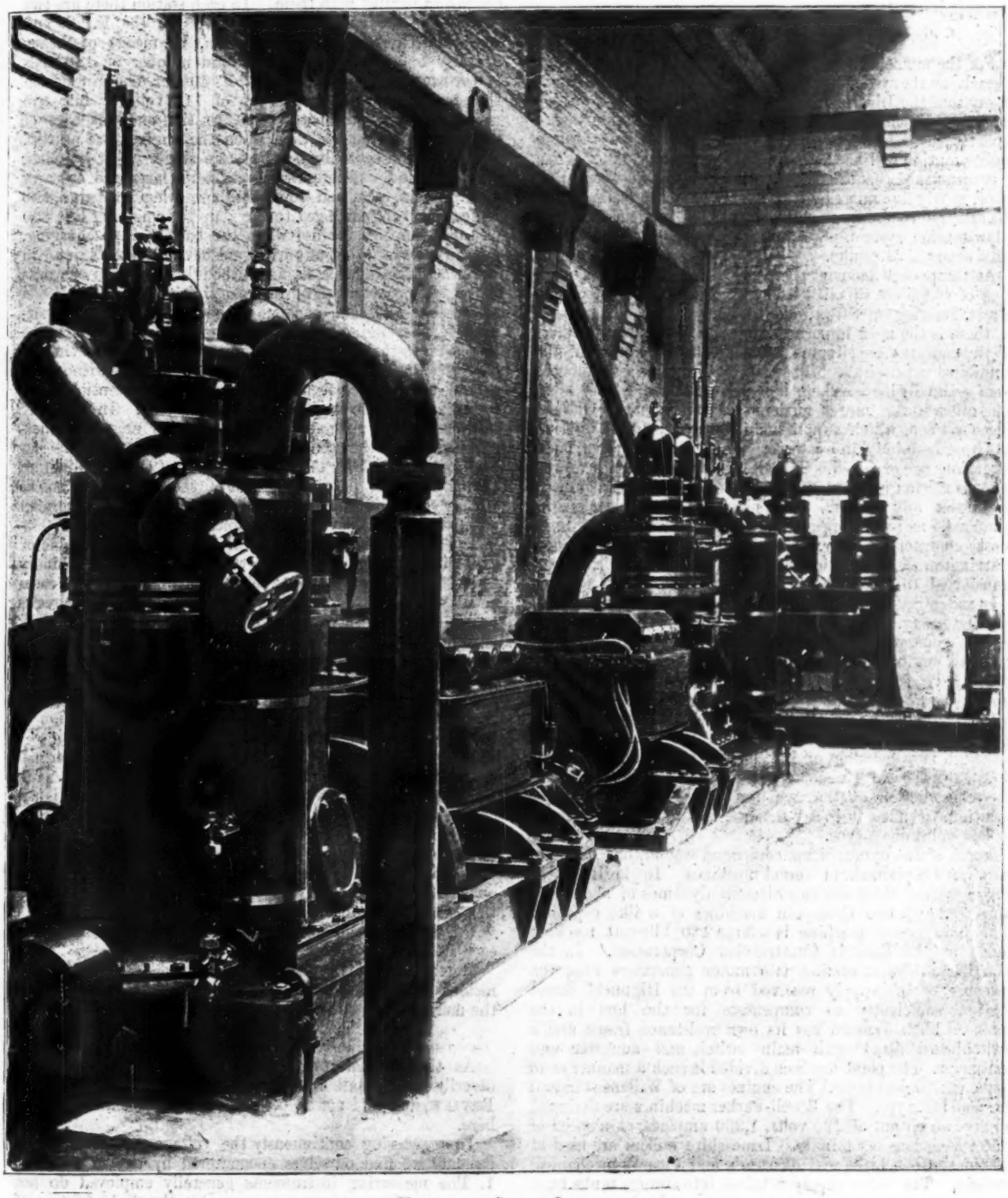
IT may be worth while to preface a description of the electricity supply in Liverpool, with a brief historical note relating to the introduction of the electric light into that important city. It is a well established fact that at the beginning of 1883 there was not a single installation of incandescent lamps in the whole of Liverpool, though in this Liverpool did not differ much from other provincial towns. In that year the Liverpool Electric Supply Company was formed for the purpose of supplying electricity from a public central station, as well as for the erection and maintenance of private installations. It will be readily understood that the operations of the company were not at the outset of a very extensive character; the initial performance was to fit up at a restaurant in Eberle Street the first installation of incandescent lamps in Liverpool. Soon after a central station was constructed in Rose Street, and commenced to run in December of 1883. This station was really built to supply the electric light to the Grand and Adelphi Hotels, but there being a little surplus energy, a few residents in the vicinity were supplied with light. The output was, however, most moderate, the total capacity of the station being under 1,000 16-C.P. lamps; still the installation continued to run without intermission down to November 1890, when the mains were connected to the new stations, and the old site abandoned.

HIGHFIELD STREET STATION.

So far as the progress of electric lighting in England was concerned, the period between 1883 and 1887 was a blank one. The stagnant state of things which supervened on the electric lighting panic was not without effect in Liverpool.

Certainly the company, to our knowledge, experienced no monetary loss through the scare, but the reaction unmistakably affected the demand for the light.

Up to the year 1887, it had not been found necessary to work under a license; but, the City authorities at this time began to take an intelligent interest in the progress of electric lighting, and it became necessary for the company to possess statutory powers before the supply of light could be extended.



HARRINGTON STREET STATION.

After much discussion the terms of a license were agreed upon, and a larger station was built in Tithebarn Street, in 1887, the supply commencing in December of the same year. The demand for current increased rapidly, and in the following year it was found necessary to build another station in Harrington Street. Fresh powers enabled the company to complete in 1889 the Highfield Street station, which was really an enlargement of that in Tithebarn Street. It was evident that nothing less than yearly extensions was requisite to keep pace with the demand, for in 1890 another station was opened at Oldham Place. This is practically the last completed station, though at the moment another is in progress of building in Lark Lane, this being the sixth in the series of the company's operations.

MUNICIPAL CONTROL.

There are few towns in England where the municipal authorities have shown greater activity over the electric light question than the Liverpool Corporation. They hold the unique position of being the only provincial town authority which has fully carried out the provisions of the Electric Lighting Acts, where the public supply is owned by a company. The functions of a municipal authority as regards the supervision of the electricity supply are of the greatest importance. It is, in fact, absolutely necessary that

there should exist for the benefit of the consumer some authorised body which will, on occasion, see that he is obtaining fair value for his money. It has been said that electricity is the only thing which cannot be adulterated, but if a drop of 10 volts in a 100-volt lamp circuit cannot be termed adulteration, we must coin a word which will express the fact that the electric light might not be always according to the standard paid for. The system of control exercised by the Liverpool Corporation is for many reasons of great interest.

THE SYSTEM OF LIGHTING.

For the moment, however, we will confine ourselves to some remarks on the system used in Liverpool. It is hardly necessary to say that the Liverpool Electric Supply Company has been for years identified with a direct low pressure system, though recently there have not been wanting indications that a higher tension will be the basis of future extensions. When it is mentioned that the city of Liverpool is a long straggling place, nearly five miles by two, it will be easily realised that the attempt to supply the greater part of such an area with a low tension system, pure and simple, would not give the most economical results.

At the present moment there are three districts or areas, each of which are supplied from stations situate in Highfield Street, Harrington Street, and Oldham Place. The former of these is the most important, and it is here that the offices of the company are situated, as well as the laboratory of the municipal authorities. The capacity of this station has been gradually increased, until at present it stands very high. The other stations are of moderate capacity, but the Oldham Place station, which supplies chiefly a residential district, has been laid down in a manner which indicates that large extensions are expected. The site which has been acquired for this station is so extensive as to accommodate machinery to almost any extent. The plant in all the stations is arranged, as will appear from our illustrations, in a most compact manner. During the summer months Harrington Street station is partially closed, and the load transferred to the Highfield Street station. These stations only are joined by heavy feeding mains, Oldham Place being too far away, is only connected to the other stations by the general network of mains. In the earlier stations separate engines and belt driven dynamos were used, but these have from time to time been replaced, the plant now being of one uniform pattern, each engine and dynamo being combined on one bed-plate. Siemens and Crompton dynamos with Willans engines are the standard plant, although new machines of Elwell-Parker type are being laid down, together with motor generators. There is nothing in the construction of the dynamos which calls for special mention. Suffice it to say that the machines are of a more or less well-known type.

Some of the dynamos are compound wound, but the later patterns are plain shunt wound machines. In the Highfield Street station there are two Siemens dynamos of about 900 ampères, and two Crompton machines of a like capacity. The most recent machine is a large 130 kilowatt machine made by the Electric Construction Corporation. In the Harrington Street station two motor generators raise the pressure of the supply received from the Highfield Street station sufficiently to compensate for the loss in the mains. Each dynamo has its own resistance frame and a switchboard fitted with main switch and ammeter and voltmeter. The plant has been divided in such a manner as to make economical units. The engines are of Willans standard II. and III. type. The Elwell-Parker machines are designed to give an output of 135 volts, 1,350 ampères, at a speed of 350 revolutions per minute. Lancashire boilers are used at all the stations, fitted with Proctor's and Vicars's mechanical stokers. The water supply is taken into storage tanks from the town mains; a duplicate service is used where possible. Two feed pumps are provided at each station, and a complete double system of feed pipes, with separate check valves on each boiler. Feed-water heaters are used and an arrangement of valves by which, in case of a breakdown of a heater, the water can be sent direct to the boiler or pumps without passing through the heater. The steam and exhaust pipes are divided into sections, so that any necessary repairs may be effected without stopping the station.

The dynamos in any station are arranged to work in parallel on to a pair of positive and negative collecting conductors, and are switched in and out of circuit as the variations in load require.

ACCUMULATOR AND SWITCHING ARRANGEMENTS.

Although secondary batteries form an important part of the system, the method of utilising is purely one of storage and not of regulating or working at balancing point, that is to say, when the engines are supplying the output the cells are not in parallel with them. In each station there are two batteries of 60 cells each, the types are the E.P.S. and Crompton-Howell. In one station, by means of heavy mercury two-way switches, the total number of 120 cells is thrown into three parallels of 40 for charging from the station mains at a pressure of 112 volts, or into two rows of 60 for discharging on to the omnibus bars of the station during the time when the engines are at rest. On the station switchboard there are single break switches, ammeters, and cut-outs, three sets being arranged to carry 100 ampères each, and come into use when charging, two larger sets being arranged to carry up to something like 800 or 1,000 ampères for use when the battery is discharging. We are not aware that any arrangement of this sort is in use in any other English station, and although the system of working may appear wasteful in theory, it is found to be a most economical and convenient one in practice, as it permits of the engines which are running light loads to be loaded up to their economical limit and at the same time of charging the batteries from the station bus bars without receiving the pressure at all above the normal potential which the engineer has to keep between the bus bars. In the other stations a motor generator raises the station pressure sufficiently to charge the accumulators when desired. The batteries have been utilised for taking up the peak of the load diagram during the very heaviest portion of the winter load, but as already stated, it is not the practice to run them in parallel with the dynamos save in exceptional circumstances.

The battery of accumulators at each station is capable of supplying 500 lamps at a time, which enables the machinery to be stopped from 10 to 12 o'clock at night, in some cases entirely on Sunday, and largely on summer days. The regulation on the feeders is maintained by the use of heavy current multiple contact switches of a special type, manufactured by the company themselves, which are used to throw in or out back E.M.F. or dead resistance cells, but very little regulation is required, except in the case of local fogs, or when the demand comes on more rapidly on one portion of the system than in the other.

Perhaps the most remarkable feature in the Liverpool stations is the absence of switching arrangements. It is in this that the stations differ so much from those one is accustomed to in London. It is a fact interesting to engineers, that single break switches seem to afford to the Liverpool Company all the control which is required for their dynamos and circuits. It is really an open question whether the quality of supply is not rather improved than otherwise by this extremely simple arrangement.

Our illustration shows very clearly the switchboard used in each station.

Hartmann and Braun's voltmeters, Nalder Brother's ammeters, and Richard's registering voltmeters, are used on the main switchboards.

THE RICHARD METER.

As the voltmeter of Richard Frères has never been described in detail in the columns of the ELECTRICAL REVIEW, we could not do better than introduce a description here.

In registering continuously the voltage or intensity of a dynamo we find ourselves encountered by two difficulties: 1. The measuring instruments generally employed do not possess the force necessary to overcome the slight friction of the pen against the paper. 2. The indications are not proportional and it is very difficult to find two apparatus the deviations of which follow the same law. The Richard meter is claimed to overcome these two difficulties. The apparatus consists in principle of a strong horse-shoe electro-magnet, before the poles of which moves a palette of a peculiar form. The energy of this system is very great and the weight required to counter-balance the value of the current is 75 grammes, a weight more than sufficient to

overcome all the passive resistances of the apparatus. Moreover, the indications are proportional along $\frac{8}{10}$ths of the scale, the two remaining tenths being exactly equal to $\frac{1}{10}$th of the course. Our drawings show the electro-magnet, E, E, which is wound with fine wire. Behind it is a large bobbin, D, wound with German silver wire calculated to absorb a certain number of volts. The section of the wire is calculated not to heat when the maximum of the current for which the apparatus is calibrated is attained. On the axle, C, is fixed a palette, P, in the form of a helix which is maintained in an invariable position by means of a weight, P, when no current is passing. When the current is passing, and the field tends to attain its maximum, the palette turns on its axle, diminishing the *entre-fer*, and the weight, Q, is displaced until it counterbalances the current measured. A stylus furnished with a pen is fixed on the same axle as the palette, and registers on one of the cylinders all the displacements of this axle. By changing the form of the palette or displacing the weight, the value of the indications is changed.

Method of Making Earth Tests.

The earth testing arrangement in use at Liverpool does not seem to have attracted the attention which its many points of usefulness would seem to warrant.

Continuous tests of the insulation resistance of the mains are made at each station by means of this apparatus, which has been devised by Mr. Bromley Holmes. If two lamps be connected in series between the positive and negative mains, and a point between the lamps be connected to the earth, the lamps will be found to burn with a variation in brilliancy proportional to the relative insulation resistance of the mains to which each lamp is attached. If two voltmeters be substituted for the lamps their readings will indicate the same ratio. In the apparatus referred to, a registering voltmeter is used to indicate this ratio continuously. By a suitable arrangement of switches, an ammeter with one terminal connected to earth can be momentarily connected to either main, and the insulation resistance in ohms of the main to which the instrument is not connected is readily arrived at by dividing the station pressure in volts by the number of ampères indicated by the ammeter.

Let reading on ammeter from best insulated side of network to earth be A ampères, and volts

$$\frac{\text{from best insulated side to earth}}{\text{from worst insulated side to earth}}$$

be $\frac{V_1}{V_2}$, then insulation of worst insulated side is, by Ohm's law,

$$r = \frac{e}{c} = \frac{110}{\text{A amps.}} \text{ ohms,}$$

and since the insulations are directly proportional to voltages between earth and the two mains, the insulation of better insulated side is equal to

$$\frac{V_1}{V_2} \times \frac{110}{\text{A amps.}} \text{ ohms.}$$

In this test the reading on ampèremeter is a measure of the insulation of the main to which the meter is *not* connected, while the two insulation resistances being in series the volts across each bear the relationship to one another of the numerical value in ohms. For example, if the station pressure be 120 volts and the ammeter reading 3 ampères the resistance of the opposite main would be 40 ohms. A reference to the drawing of this arrangement will make the matter clear.

The ammeter used for testing must be accurate at low readings, and therefore is only made to read up to five ampères. In the event of any dead earth fault on the mains, the instrument might be destroyed by the sudden rush of current, and to prevent such an accident a magnetic cut-out is placed in series with the ammeter. When more than five ampères passes through the cut-out it breaks contact, leaving in circuit a resistance coil of 25 ohms, so that the current through the instrument, with a station pressure of 125 volts, cannot exceed five ampères. By this contrivance it is possible to measure faults of very low resistance.

For the exterior view of this testing set we are indebted to Messrs. Nalder Bros.

The System of Distribution.

The system of mains is entirely on the simple tree system; that is, feeders either of a single pair or several pairs of mains in parallel supplying a certain district which is in connection with no other district.

Up to the year 1889 the company were doing, if not all, certainly the largest portion of their supply through overhead cables. To such an extent do the engineers of the company believe in the adaptability of the low pressure storage battery system, that for their new station in Lark Lane they have designed a three-wire low tension system.

All the distributing mains have been manufactured and laid by the Callender Company.

The mains are laid in cast-iron troughs ½-inch thick and about 6 feet long, with socket joints. When the troughs are placed in position about ½-inch of refined bitumen in a molten state is run in, and, before setting, spacing bridges of wood are placed in it about 18 inches apart. These bridges support the cables and hold them in place, clear of the sides and the bottom of the trough and of each other. Bitumen is then run in so as to entirely cover the cables and fill up the iron troughs to within ½-inch of the top. The troughs are then finished by a covering of Portland cement concrete about one inch thick. Strong cast-iron covers are in some cases substituted for the concrete.

The conductors are of stranded-copper wire, with a conductivity stated to be 98 per cent. There are several classes of cable which are enumerated in the following table.

The largest feeding mains are composed of 91 No. 9 wires, and have a sectional area of 1·57 square inches, numbered "G" in the table. The conductor in this cable is covered with two layers of jute yarn and boiled in refined bitumen. It is next wrapped with parchment tape and covered with a lead casing. The lead is protected by an outside covering of rough jute yarn treated with asphalte and tar.

The ordinary feeders are made of 61 No. 11 wires with an area of ·6 of a square inch, and the distributors of 37 No. 13 wires one-quarter of a square inch in area. In both these mains the copper conductor is covered by a solid sheath of bitite or vulcanised bitumen put on under heavy pressure at one operation. This core is next taped and compounded, and finally braided with hemp yarn and passed through a bath of asphalte compound.

Service lines were formerly lead-covered Callender's cable run in wooden casing, but the results were unsatisfactory, and the company are now using bitite cables run in iron troughs and filled up with bitumen, as is usual in the Callender system of mains. There is reason to think that this arrangement has proved satisfactory.

Besides the feeders mentioned there are the distributing mains. The distributors are made in two grades, heavy and light, called, respectively, C and D.

Electric Light Cables.

Letter on plans.	Total area of conductors in square inches.	Each wire.			Weight of copper.		Resistance.		Full load in ampères.	Drop with full load per 100 yards main, in volts.	Drop per 100 yards, per 100 ampères of main.	Weight of 1 yard of single cable, in lbs.
		No. of wires stranded.	Diameter in inches.	Nearest B.W.G.	In each cable per 1,000 yards, in lbs.	In entire main per 1,000 yards, in lbs.	Of each cable per 1,000 yards, in ohms.	Of entire main per 1,000 yards, in ohms.				
				No.								
A	1·20	2/61	·112	11	7,000	28 000	·040	·040	1,200	4·80	·40	
B	·60	61	·112	11	7,000	14,000	·040	·080	600	4·80	·80	10
C	·50	2/37	·092	13	3,000	12,000	·100	·100	500	5·00	1 00	
D	·25	37	·092	13	3,000	6,000	·100	·200	250	5·00	2·00	
E	·85	61	·112	11	7,000	20,000	·027	·054	850	4·79	·54	
		37	092	13	3,000							
F	·10	19	·080	14	1,150	2,350	·250	·500	100	5 00	5·00	
G	1·57	91	·114	9	18,400	36,800	·016	·032	1,500	4·80	·32	56

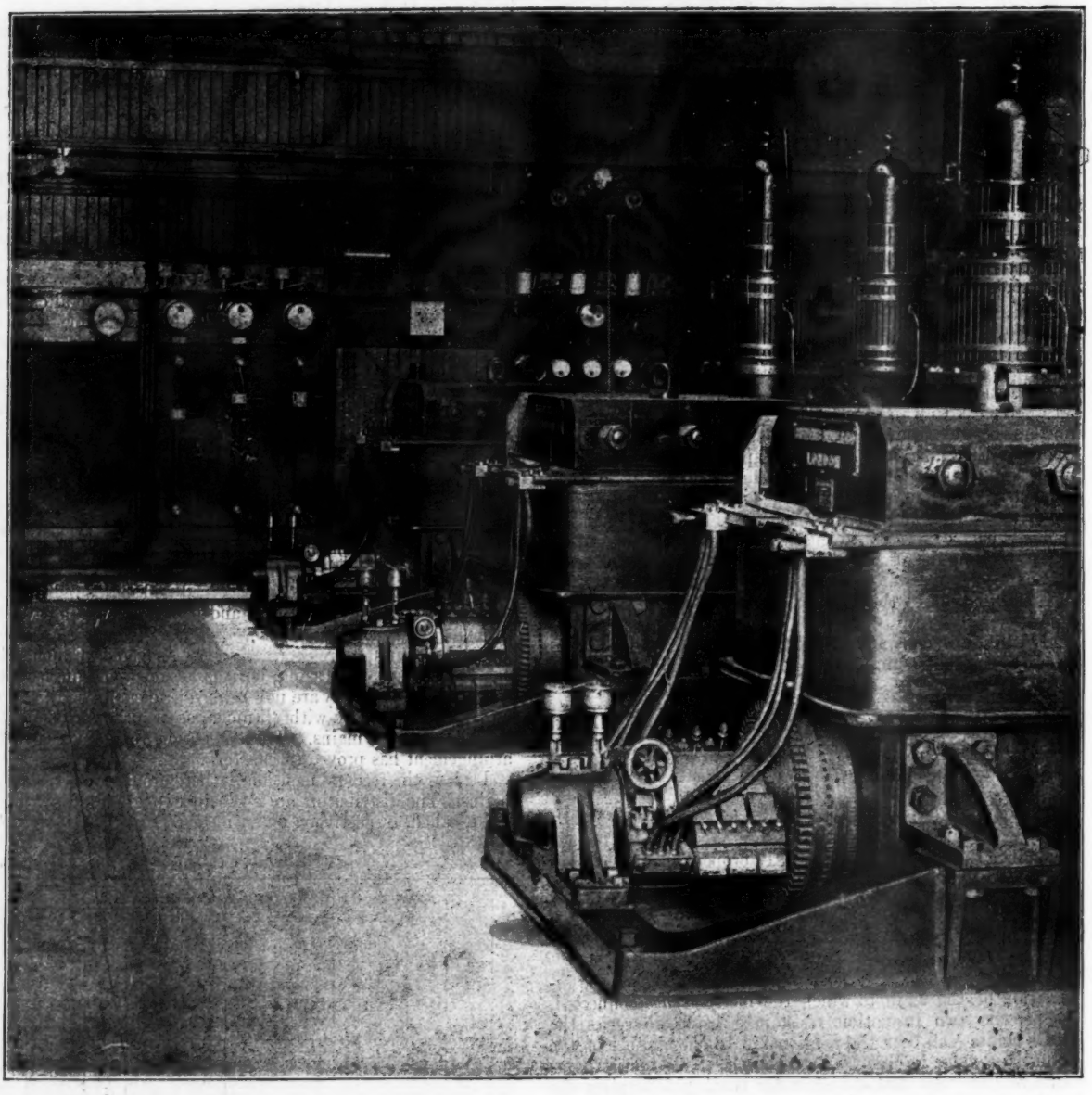
The service wires are lettered F. E is a composite main, consisting of feeder and distributor. G is a type of heavy station feeder, adapted for conveying a heavy current from one station to another in case of a breakdown at a station.

There are, in fact, altogether, seven sizes adapted to the requirements of the seven classes of cables, corresponding to which the conduits are lettered A, B, C, D, E, F, and G. The first five are made of cast-iron, without covers, the layer of cement being substituted. A holds two (horizontal) layers of cables, each consisting of two parallel cables, or four in

all—two positive and two negative. B holds but one layer of two parallel cables. C is similar to A, but, of course, of less cross section, as it is intended for the distributing cables, which are smaller than those classed under A. D corresponds to B on a smaller scale. E carries the composite mains. F is simply a wooden trough made from a piece of timber, with two parallel grooves of semicircular section running along its upper face. The service wires are laid in these hollows and are held down tightly by a thick layer of cement. G, the station feeders, contains only two cables, one placed vertically over the other, with a cast-iron cover over them.

Whatever the character of the ground traversed, the depth of a particular grade of conduit below the surface is constant. The depth, however, is different for the various classes of mains, and is also required to be greater when the cables are laid under the roadway than when laid under the sidewalks. It is stated that these depths, which are specified below, are rigidly adhered to, and application must be made to the inspecting electrician of the City Corporation for a permit either to continue the excavation to a greater depth or to bring the conduits nearer to the surface. Similar application must be made for a horizontal deviation from the approved route.

The depth under roadway (concreted) is as follows: A, 2 feet 6 inches; B, 2 feet; C, 2 feet 6 inches; D, 2 feet; E, 2 feet 6 inches; F, 1 foot 6 inches; G, 2 feet 6 inches. The depth under sidewalk (clear) is: A, B, C, D, and E, 1 foot; F, 6 inches; G, 2 feet.



OLDHAM PLACE STATION.

ARRANGEMENT OF MAINS.

The general arrangement of mains is as follows:—A pair of distributing mains are laid under the footways on each side of each street, and are connected together to form a complete distributing network, to which are connected all the service lines to consumers' premises. For convenience in working, the network is divided into sections. The supply of current is brought to selected distributing points in this network by heavy feeding mains, which run direct from the generating stations.

The feeding mains are so proportioned—relatively to the distance from the station of each distributing point and the number of lamps to be supplied from it—that the percentage of loss in pressure in each feeding main may be as nearly as possible the same; in other words, if the lamps were turned on and off uniformly all over the area of supply, a constant pressure might be maintained throughout the network by varying the E.M.F. of the dynamos at the central stations in exact proportion to the amount of current supplied.

As a matter of practice, however, the hours of demand vary in different streets and districts, and it is found

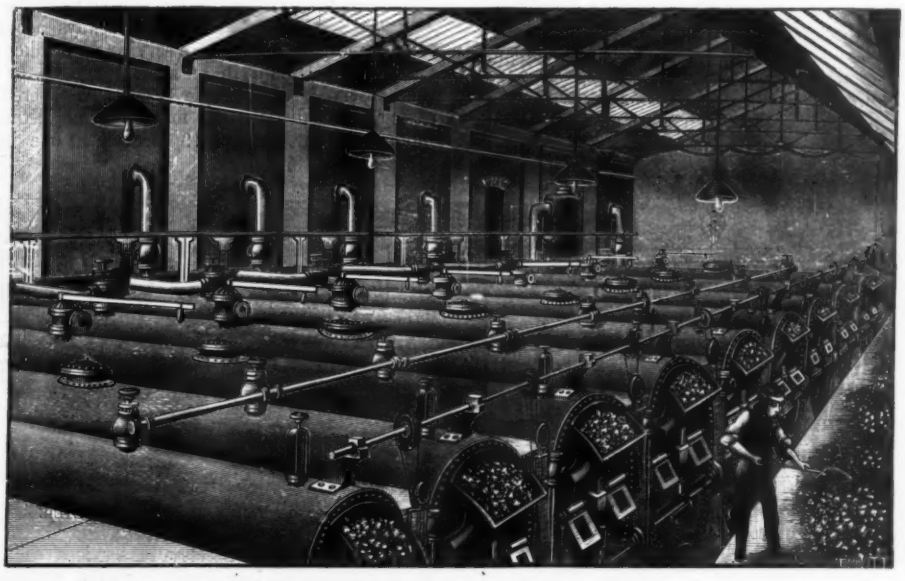
necessary not only to vary the station pressure as a whole, but also to regulate the pressure for each set of feeders individually.

Pressure wires are run in specially laid cast-iron pipes from the various distributing points to the central stations, and are connected to instruments, by means of which the actual pressure at each point is indicated to the engineer in charge and is continuously and automatically registered.

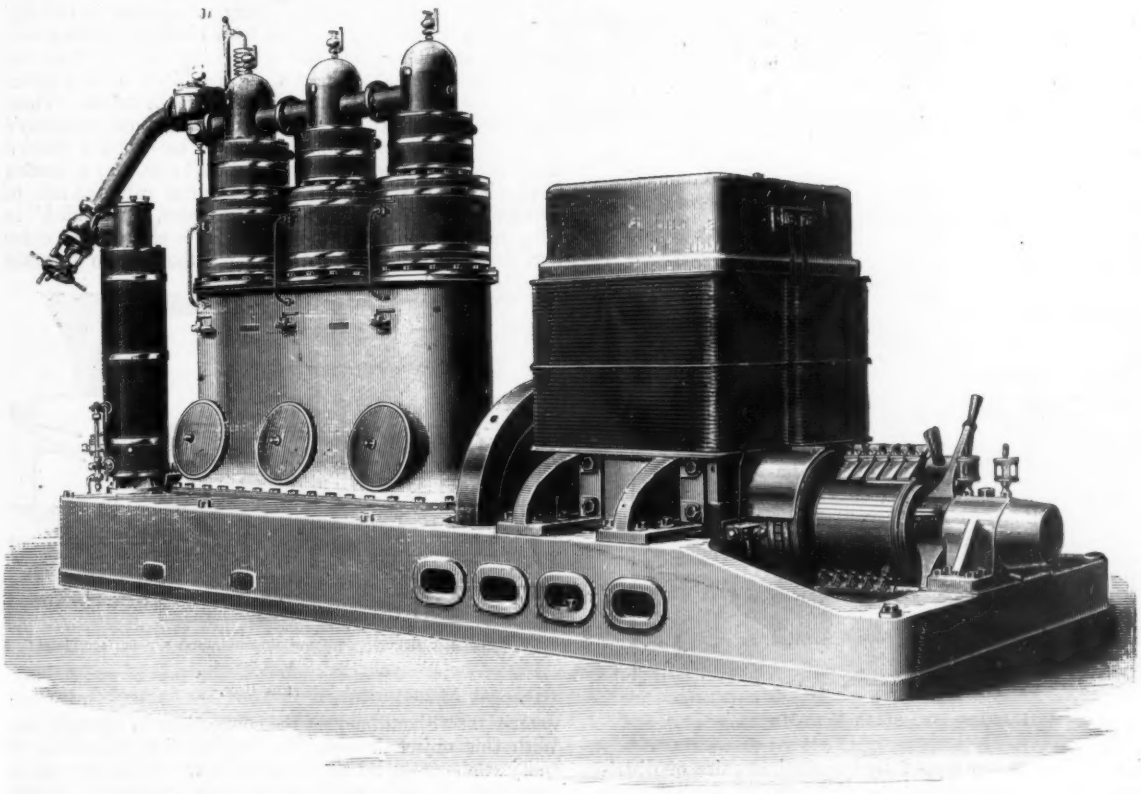
The street mains are connected up to massive terminals on the switchboard fitted with safety cut-out strips, which would fuse in the event of any serious short circuit on the main.

Each negative feeding main is connected from its cut-out to the station main negative conductor, and each positive feeding main is connected through an ammeter to a main regulating switch, which, when in its normal position, completes contact with the station main positive conductor. By moving the regulating switch it is possible to introduce a number of accumulators, one after another, in the circuit of any desired feeder. These accumulators are arranged in opposition to the dynamo current, and, consequently, the pressure in the feeder is reduced by two volts for each cell put into circuit by the regulating switch.

This at first sight may appear a wasteful method of regulation, but in practice the load is found to rise so uniformly over the whole area of supply that the amount of energy absorbed in regulation is practically unimportant.



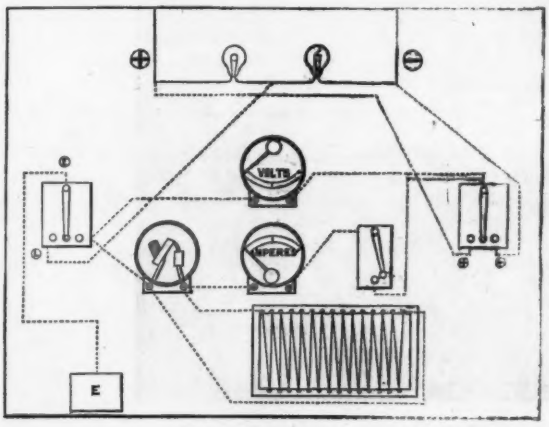
PROPOSED BOILER HOUSE FOR OLDHAM PLACE.



COMBINED ELWELL-PARKER DYNAMO AND WILLANS ENGINE.

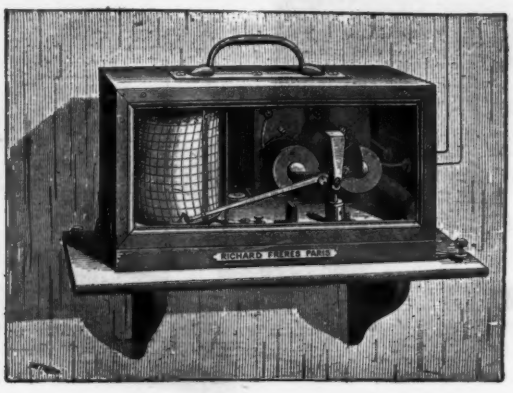
SERVICE AND JUNCTION BOXES.

The service boxes are placed opposite the centre of each block of buildings, the various connections for the houses in that street or section of street radiating from this box being formed by laying the lead-covered 19/14 cables in wooden troughs filled with bitumen. Thus one junction service box, as a rule, serves several houses, although in some cases when a large establishment takes a great number of lights a special junction box is used for this one place alone. The cables connecting to the customers come in at the side of the box, as seen from our drawing, and are brought up to bronze connections, from whence they can be connected across to the mains, and cut-outs are usually inserted at the junctions. The boxes are not built up close with brickwork, but a space of about 1 inch is left between the outside of the box and the inside of the brickwork, so as to afford proper drainage. The cover of the box and the street cover are quite separate, and a varying distance intervenes between them, being sometimes over 3 feet in the case of pressure-wire boxes. The boxes are tightly sealed, and the conduits, being solid, accumulation of gas is prevented.

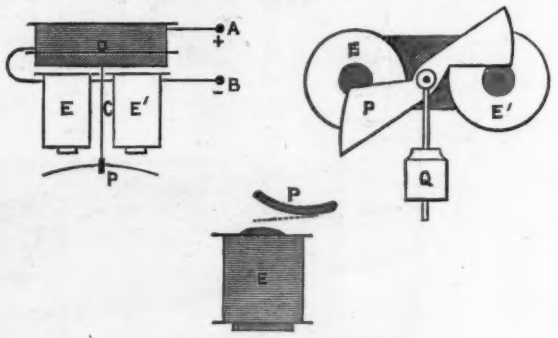


EARTH TESTING SET.

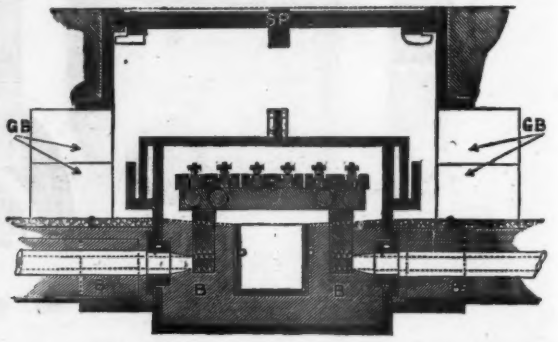
The joint box takes two pairs of feeders, and two pairs of distributors laid in an iron trough (6 by 6 inches of ¼-inch iron). As connected up two distinct pairs of feeders are tapped by two distinct pairs of distributors. If it were necessary to couple all in parallel or to couple in any other variation, it could be done very simply by the copper connecting pieces. Copper pieces are sweated on to the ends of the conductors, and the joint thus made is perfectly insulated with bitite. The insulated joint is next treated with Callender's insulating wax compound, which preserves it against moisture and insures a perfect insulation. The copper connecting pieces are fixed to the lugs by means of phosphor bronze set screws. Before being placed in the ground the boxes are boiled in fine bitumen in order to preserve the iron and ensure a water-tight joint between the bitumen and the iron at all points of contact. Especial care is taken to seal with bitumen the apertures through which the cables enter the box. The India-rubber washer used between the cover and the box is fastened with India-rubber solution to the lid, and this method of fastening the lid down is found to be excellent. The crossbar can be removed easily when it is necessary to get at the connections. All the boxes (except one class to be mentioned later) have a surface cover, so that they are always accessible without raising the pavement. The service box takes a pair of distributers 37/13 laid in an iron trough 4½ by 3 inches, and the household service cable 19/14 lead-covered laid in wood casing. The distributing main is in no instance tapped for more than four pairs of 19/14 cable at one box, forming in this extreme case four separate services, each with a maximum capacity of 100 ampères and a working capacity of 90 ampères. The connections are made from the main to the service cables by lead fuses intended to melt at 140 ampères. The service cable entering its aperture in the side of the box is held in position by a block of bitumen wax run solid around it (the lead casing being cut away from the end of the cable inside the box). The block of wax serves to keep the box water-tight and insulates the cables. These boxes have surface covers. Where more than one consumer's premises, with separate frontages, are to be supplied from a single service line (*i.e.*, a pair of 19/14 cables) a branch service box is used, which takes the pair of cables as laid in wooden casing. The box, as in other cases, is "pickled" in bitumen and supplied with a cover. It is placed in an outer box, the object of which is to enable the box to be made water-tight without burying the connections in bitumen wax. With this object the outer box is filled with bitumen up to and just above the lid of the inner box. When the connections have to be opened up, the thin coating of bitumen over the surface of the lid is broken and the lid removed. A disconnection can thus be rapidly made. Such a box is used without a surface cover, and its position under the sidewalk is indicated on the flagstones above it. The surface covers for feeding joint and service boxes are supported free from the boxes by brickwork.



RICHARD RECORDING VOLT-METER.



PARTS OF RICHARD METER.



B, Bitumen; C, Concrete; P, Porcelain Insulators; S, P, Surface Plates; G, B, Glazed Bricks.

SERVICE BOX.

There have been on one or two occasions difficulties in the joint boxes from the access of water, which has startled the public by one or two cases of electric fires; we are informed, however, that these events have been much exaggerated, the

cause is due solely to the restricted size of the joint boxes, which the former engineer of the corporation would alone permit to be laid in the streets; the company, however, have now gained their point, and with the greater liberty allowed them by the local authority, there has been no further trouble from this cause.

The laying of mains is carried out by the company under the personal supervision of the corporation's electrician. The cost of the more expensive conduits, finished, is as much as £3 2s. 6d. per lineal yard, while the cheapest costs about 16s. 4d. per lineal yard. The final repaving of the pavement is done by corporation workmen, the cost being borne by the electric light company.

PRICE PER UNIT.

The method of charging for electricity was for some time carried out on a sliding scale, depending on the maximum current used. The schedule of prices given in the Liverpool Electric Light License for 1888 was as follows:—

1. For any number of units up to 100 times the number of units per hour of maximum demanded supply, 1s. per unit.
2. For any further quantity up to 100 times the maximum demanded supply per hour, 8d. per unit.
3. For any further quantity 4d. per unit.

As pointed out by Mr. Bromley Holmes in the ELECTRICAL REVIEW some weeks ago, it was found that customers had some difficulty in understanding the scale, and some dissatisfaction was felt among the smaller consumers, of whom there are many who never reached the lower scale. Four years' trial of this method of charging has proved that it is on the whole unsatisfactory and a uniform rate has been adopted. The present price is 7½d. per unit, and it will be interesting to note any increase in the number of consumers. There are at the present moment nearly 17,000 16 C.P. lamps connected on to the supply. It is a curious fact that the maximum demand for light for more than half of the consumers does not exceed 10 ampères.

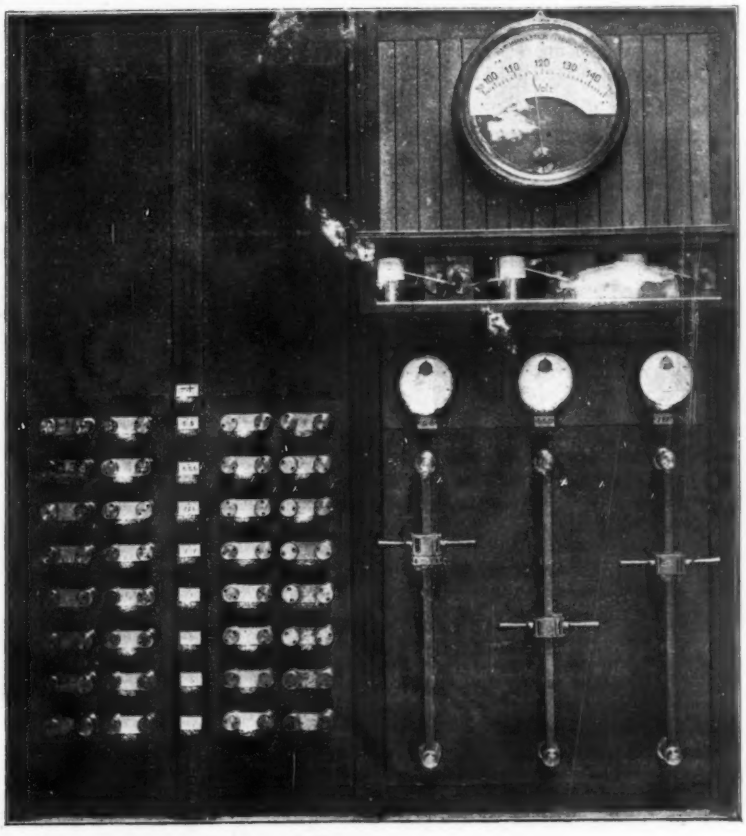
What appears to us to be an exceedingly high lamp factor is reached at times, 75 per cent. of the total number of lamps installed being very often lighted at once. 700 is the average lighting hours for each lamp per annum.

COST OF PRODUCTION.

Although the cost of production is by far the most important question in generating stations which have been established as long as those in Liverpool, we are not able to give full details.

In the first place no record is made of the units-generated at the stations, hence we are unable to arrive at anything approaching actual loss in distribution.

There are many things which unmistakably point to the Liverpool Electric Company as possessing advantages second to none. The revenue earned per lamp is good. It has a lamp density of a lamp per yard of main, which is surprising considering the straggling nature of the area. It may be appreciated when we mention that the supply from Highfield Street is carried a considerable distance through a poor neighbourhood before a lamp is lighted. The importance of this cannot be over-rated in a low-tension system. A more central position for the station is precluded from the nature of things which prevails in Liverpool. The figures which have been placed at our disposal are, perhaps, a little rough, but they cannot fail to give some fair notion of the commercial results.



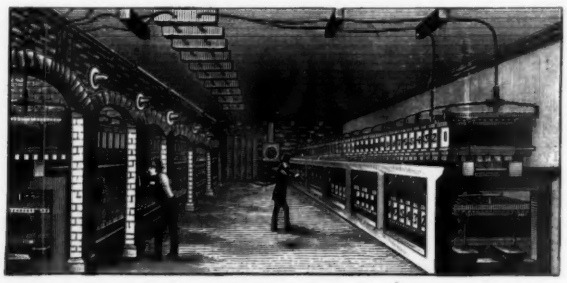
SWITCHBOARD.

The total charges on each unit is 4·93d., this being due to heavy charges for the depreciation and redemption fund. Nearly 24 per cent. of the revenue is devoted to these accounts, which is, perhaps, the highest of any company in England.

In dealing with the cost of electricity, it must be remembered that we are dealing with three stations. The total works cost per unit is 2·48d., made up as follows:—

Coal	·96	per unit.
Oil, waste, &c.	·21	„
Salaries and wages	·48	„
Repairs and maintenance ...	·6	„
Miscellaneous, &c.	·23	„
Total	2·48d.	

This is exceedingly low, and, after that of the Newcastle-on-Tyne Electric Light Company, is the best for companies in the country. Were it not for the fact that ·6d., against ·24d. for the Newcastle Company, is charged to repairs and



BATTERY ROOM.

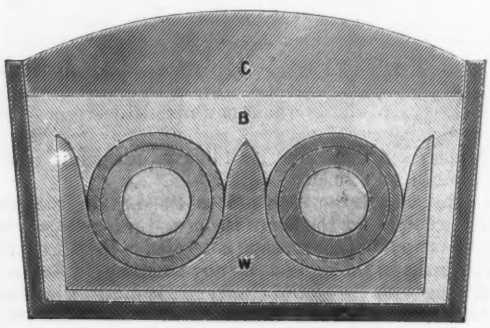
maintenance, in addition to the exceedingly heavy sums given to depreciation, the works cost would be the lowest.

Management expenses are fairly small, being ·67d. per unit, but the large items of 1·16d. to depreciation account and ·62d.

TESTING SET.

to redemption fund bring the total charges to 4·93d. per unit.

All things considered however the position of the Liverpool Electric Supply Company seems to outsiders to be most



W, Wooden trench; B, Bitumen; C, Concrete.

SECTION OF CABLE.

satisfactory. A dividend has been earned since the first year's operations, but how much of this dividend has been earned from erecting private installations the company's accounts do not show.

METERS.

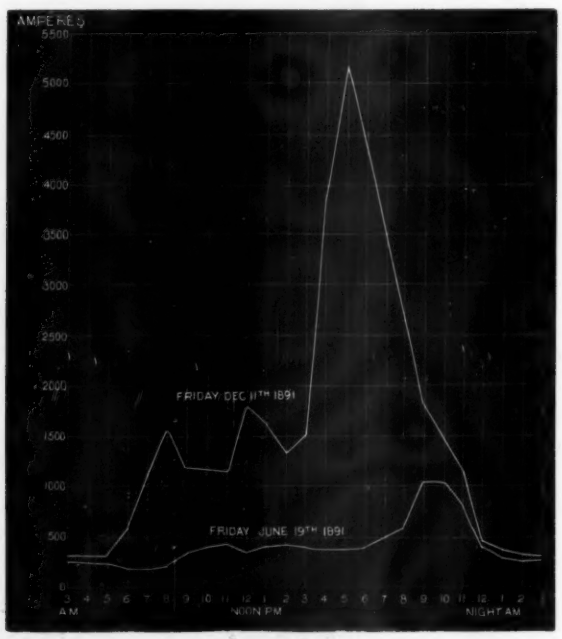
The rent of meters in Liverpool of less than 50 ampères is 30s. a year, with an additional charge of 4s. a year for every ten ampères over 50. This is a somewhat heavy charge and may be perhaps attributable to carrying out the clauses of the provisional orders for testing and certification of meters and other necessary although expensive protection which the legislature of this country has seen fit to impose.

The Hookham meters were at one time used very extensively in Liverpool; they were usually tested and sealed by the corporation under a provisional approval of the Board of Trade given to the meter in January, 1889. The full approval has never been given to this meter. The Ferranti meter is the one now most in vogue at Liverpool. It must be remembered that the corporation, through their electrical inspector, are more or less responsible for the general good working of meters, a fact which will be dwelt upon later.

MUNICIPAL TESTING.

This article would be incomplete if it did not include some account of the municipal testing arrangements.

The first electric inspector ever appointed in this country



LIGHTING CURVE.

was in Liverpool, and dates from August 27th, 1889, when Mr. C. H. Yeaman was nominated to the post. Some time was spent in preparing and getting instruments together, but meter-testing was actually commenced in April, 1890.

The laboratory has been equipped throughout by Messrs. Nalder Bros. & Company with specially designed instruments, and has a complete equipment for measuring currents, from $\frac{1}{10000}$th of an ampère to 250 ampères; the current required is got from a battery of 64 11 E.P.S. cells, giving pressures either continuous or alternating, from $\frac{1}{1000}$th of a volt to 500 volts; the results are, as far as possible, standardised from Clark cells and standard resistances, and are checked, where necessary, by Thomson balances, ampère and volt, gauges, and multicellular voltmeters. Pressure wires are brought into the laboratory from various parts of the area of supply, and it is the duty of the inspector to record any fall of pressure.

The duties of the municipal inspector are of a responsible nature, and as these are performed strictly according to the terms of the provisional orders, a consideration of them will be of interest.

The inspector must hold himself in readiness to test for the corporation the conductivity and insulation of the mains of the undertakers within the area of supply. Service lines are tested in a similar way. A report is then presented to the municipal authorities. Where the report shows the

mains or service lines were faulty, the cost of tests is borne by the Electric Light Company. In the event of a customer complaining of the service, tests would be made, and the lines being perfect, the cost would be borne by the consumer. The local authority have the right to test instruments used by the company; all such instruments are to be kept in working order. Regulations are enforced for the proper maintenance of pressure in the mains. Consumers' meters are tested at the laboratory, and the corporation seal attached.

In conclusion, we must thank Mr. Bromley Holmes, Mr. C. H. Yeaman, and Mr. Clough, for the assistance given in the preparation of this article.

ECONOMY OF TRIPLE EXPANSION ENGINES.

ALTHOUGH Americans were not very quick in their appreciation of the advantages and economy of the compound as compared with the simple steam engine, they have not exhibited the same slowness in taking up with the triple engine, and in *Cassier's Magazine* we find several illustrations reprinted from *Engineering*, of various engines, both triple and compound, of both French and English build, notably the engines of the "Pallion" and "Stranton" by Messrs. T. Richardson and Sons, of Hartlepool, and those of the torpedo boat *Nuluca*, by the Forges et Chantiers Cie., of Havre.

In the English example above, the original compound engines had cylinders 33 inches and 61 inches × 33 inches stroke, worked at 75 lbs. boiler pressure, and their builders have converted them to triple expansion, as follows:—New boilers, capable of working at 170 lbs., were put in, and an additional entire engine added to the forward end of the old engines, and the old low-pressure cylinder was reduced to 56 inches diameter by a liner. The three cranks were placed at 120°, and the new high-pressure cylinder is jacketed with steam at boiler pressure, and exhausts into a receiver which forms, as it were, a jacket upon the jacket, and this receiver is fitted with a series of internal ribs or partitions which compel the steam in its passage to the intermediate cylinder to traverse over the whole surface of the heating jacket, so that it enters the second cylinder well dried. In addition, there is also an evaporator to produce fresh auxiliary feed water with a steam jacket, and this takes steam from the high-pressure jacket, which therefore drains into the evaporator, and there is thus ensured a circulation of steam through the jacket, and, finally, the steam heats the feed water. As a result of the changes, the coal consumption was reduced from fully 12½ to 8½ tons daily, with a very slight increase in the speed. Practically, a third of the coal formerly used was saved, and though no figures are given of the cost of the alteration, it seems likely that the saving effected will show a good return on the investment.

Though all the saving may not be due to the triple principle, it is not probable that the various other improvements can be credited with by any means the major portion, and though there are still many engineers who consider that the compound principle has no advantage over the simple, we think there is sufficient evidence to prove the contrary. In the case of a ship especially, running over a certain course, the mean of several voyages, before and after conversion to a higher grade of expansion and pressure, may be taken as genuine evidence of any benefit or otherwise arising from the change. We are not ourselves keenly susceptible to the economies shown by set trials, professorially superintended, however honestly conducted, but we do think that shipowners, who are guided by ledger balances, may be trusted to know if higher grade expansions can pay. Even if it be granted that steam of 170 lbs. pressure will show as good results in a single cylinder as in a compound or triple engine, and we are far from saying that a large increase in gross horse-power is not a probable result of compounding, still there remains the fact of the enormous reduction in stresses consequent upon compounding, and this too even when all the cylinders of a compound engine are upon one piston rod, tandem fashion. Economy from compounding may be and most likely is, largely due to purely mechanical effects quite as much as to thermal actions, for in compound engines there is in addition to reduced stresses on crank pins, a very great reduction of the length or area of high pressure leakages at valves, round pistons, &c.; there is the saving of such steam as does leak past even reduced dimensions by the next cylinder, and there is the reduced radiation surface at the higher temperatures, which we may class as a partially mechanical effect. On the whole, the triple principle seems fairly to have proved itself capable of utilising steam of higher pressures, to which its critics are apt to give all the credit, as though the raising of the pressure were not really an essential of higher grade expansion. When the late Daniel Adamson failed to get the results he hoped from his quadruple engine, it was simply that he had but 100 lbs. in his boiler, and this was only a fit pressure for a two cylinder compound. He taught the valuable lesson that an additional cylinder was warranted only by a certain additional pressure, and the converse of course equally holds good. Undoubtedly too, as stated, the diameter of the furnaces of the *Pallion* and her sister ship—viz., 45 inches externally, has something to do with the good results. It is impossible with small furnaces to secure that thorough combustion which takes place in a more roomy furnace, and undoubtedly a thick fire in a short grate will give better results than a long thin unmanagable fire which continually burns into thin and weak places passing an excess of uncombined air. It is, after all, to the boiler maker we must look for any further advance. All past advances have but waited the growth of the boiler to become practical facts, and since the abolition of tallow and its substitution by non-corrosive undecomposable mineral lubricants we seem to hear very much less of the deterioration of the cast-iron of steam cylinders, which was formerly credited entirely to hot steam and not to the acid re-action of decomposed fats. As the Americans would say, triple expansion has come to stay.

LEGAL.

NATIONAL TELEPHONE COMPANY *v.* GRAFF-BAKER.

High Court of Justice.—Chancery Division.

(Before Mr. Justice Kekewich.)

(*Continued from page* 794, *Vol.* 31.)

SECOND DAY (*continued*).—DECEMBER 14TH.

The cross-examination of Sir FREDERICK BRAMWELL continued by Mr. BOUSFIELD:

Now, at Vevey, you have expressed the opinion that upon that system there would be no more difficulty in providing for crossings with the double conductor than with the single conductor?—I did not put it in that way. I said there would be difficulty; I did not make it a comparative. Perhaps you will say that is higher than a comparative. What I meant was this: take a tramcar with two wheels on the one side, and two on the other. At present the defendants use all those four wheels for the purpose of making connection to the return circuit, as you have just pointed out; but to illustrate what I mean, say that one of the rails brought the positive current and the other only took back the negative current. It is perfectly obvious that you could make proper turnouts and crossings and all that kind of thing for that tramcar to work, because its wheels must go through; it cannot possibly work along the tramway unless its wheels can pass all the various crossings. If one wheel carried a positive conductor and the other a negative conductor you solve the problem. I do not suggest you could do it by wheels; I suggest you could do it by shuttle. But then where a wheel would go a shuttle would go, and you would drop one of your conductors below the level of the other, so that the shuttle could not make a short circuit between the positive and negative sets, and it would be of such length as to bridge over the opening. I see on the Giant's Causeway, where they have only the single conductor, that is broken by gates. It is about 18 inches from the ground, possibly; it is an iron bar, and when they want to get through gateways into fields that conductor is broken, and you have by brushes on the car means of bridging over the gap.

Your view is that the double conductor system, as regards these crossings, is only multiplying the single conductor system by two?—I do not know that, but what I do say is that the two sets of wheels, one on each side of the car, must traverse the various rails. You have only to bear in mind that one of these wheels is bringing positive electricity and the other taking negative, to see that if they would do it with wheels they would do it with conductors.

There is just this point between us, that you have the tops of these rails, of course, on the level, which is permissible. You can cross on the level from the left rail to the right rail?—Yes.

But when these are conductors you would cross on the level, but you must make a break wherever a positive wire crosses a negative?

—Then I am afraid I have not followed you. I say yes, subject to this, that I am afraid I have not made myself clear. You cannot cross through one rail to another without having a gash in the vertical rail. That you are obliged to do to allow the flanges of your wheel and the other line to come together. The smaller end of the rail which stands above has a depression in the particular conductor which you do not wish to touch when you are passing over it, and when, as I say, the shuttle would bridge the space.

You mean to say by means of systems of gashes you could have as many crossings as you like?—Gash is the word applied to the rail; as to the other I said lowering, but I am quite willing to adopt your words. I say lowering, getting the two things out of one plane, so that at least the one plane does not touch the other.

I would rather, if you do not mind, you would keep to this for a moment. You have had overhead conductors; you must provide that where they cross a conductor not one line is broken, and you must bring it over by means of a continuation that is out of the plane of the conductor? In order to make it practicable to have crossings with that double conductor system, whenever a positive wire crosses a negative wire you must, as far as the plane in which they have to lie affects their contact, have in that plane a break of one of the wires and a bridge over the break by means of a wire connecting the broken ends a little above in another level?—Yes; that is what I call the bridge for the purpose of maintaining the permanent current in the wires.

Where you have a complex crossing, such as that at Boar Lane, Leeds, the number of breaks or gashes would be very considerable, would it not?—I heard Dr. Hopkinson say there would be six.

It is perfectly practicable, notwithstanding that?—Yes.

May I ask if you have ever had to apply your mind to a case of that kind, with double conductors, and to try to scheme it out so as to make a practicable tramway system out of it?—No, I have not.

Do you know if it ever has been done at all on a double conductor system?—I do not know.

There is a model put before you as an attempt by one of our witnesses to show how that would have to be schemed on the double conductor system.—Then I presume he has done it.

I ask you whether the complexity of the arrangement and the expense of it, having regard to the stoppage of a tram in a street, is not such as to condemn the double conductors in the streets of a town like Leeds?—I do not know what you mean by the stoppage of a tram. If you mean there must be interference with the connection between the conductor and the motor on the tram at any point, I do not agree.

I ask you whether the complexity of the thing, first of all, is not sufficient to condemn it as a practical system?—I answer no, it is not, because I again come to the answer which I have given, that it is simply doing by sliders or shuttles for electrical connection the very thing you have to do on the wheels of the tramcars.

Is not the risk of short circuiting, again, such as practically to condemn that?—I should have thought not, if the thing is properly done.

And with reference to the stoppage in the street which must necessarily take place where these gashes are, that would not render it simply impracticable?—I simply do not understand your question. If you mean the car stops to take up passengers, I do not see what that has to do with it. If you mean, as I gathered from a question you put yesterday, there must of necessity be a cessation of electricity between the conductor and the motor of the car, I do not agree with that.

You think it could be provided for by two brushes?—Yes, by what I call an elongated shuttle. Before you lose connection at one part of the conductor you have it made with the other part.

But if each of those brushes happens to come on a gap, then the continuity of the circuit would be destroyed?—If you have a gap and you have something longer than the gap you cannot have the whole brought into that gap.

You may have one gap here 2 feet 6 inches long, and another gap near it 2 feet 6 inches long, and you might then get to a position where one part might rest on one gap and another on another?—I do not see any objection to that if the intermediate part is competent to conduct electricity.

You are thinking of something in the way of a continuous brush?—Yes.

Nobody has suggested the use of that for tramways?—I am inclined to think that the brush at the Giant's Causeway is some very considerable length, 2 feet, or so; but whether they have suggested it or not, I see no possible objection to it in ordinary working.

When you get to a curved part, what is to make your brush follow the curve?—Guiding sides.

Have you ever actually worked that out?—No.

You are inventing that as you go on?—What I am endeavouring to do is not to be supposed to be deprived of my ordinary common sense as a mechanic in dealing with a question of this kind.

It is a very complicated thing, is it not?—It is a complicated thing, and not a very complicated thing. If you see the points and crossings on an ordinary railway going into a station, the crossovers, I agree, are complicated things, but they are not so very complicated that they are not fit for ordinary everyday working.

There is no risk of short circuit on them?—There is a risk of getting off the rails and turning over and killing the passengers.

You express the opinion, I think, that secondary batteries carried on the car would provide efficient means for working these tramways?—Yes.

Do you know any cases in which the secondary batteries have not been abandoned after they have been used for this purpose?—I was under the impression that Birmingham had not been abandoned, but I have not been there lately.

I am instructed that they are abandoned there. One difficulty with secondary batteries, of course, is that the plates are somewhat delicate, liable to be destroyed and drop off, and that the shaking and the washing of the liquid in the cars destroy the plates?—I should have thought that could be got over. No doubt that is an expensive means of working, but it saves a great deal of plant and machinery in laying down your tramway.

You may have heard of instances of trams supplied with secondary batteries stopping when they were out some distance from home, or from a charging station, and having to be towed home by means of horse power or otherwise?—If so that is mere mismanagement; it might be equally true of a locomotive which had not got a sack of coal on board.

It is not quite so easy, is it, to see whether a secondary battery is fully charged as to tell when an engine tender is full of coals?—There is no doubt in these days you do know when your battery is charged.

When you have got your secondary battery charged and on board it may be discharged in a way which the driver is not cognisant of, may it not?—Yes, if his information is bad.

Therefore it may happen that it is calculated to run four journeys, and for some reason it may be exhausted at the end of three and a half?—It might.

And that would cause the difficulties which have been felt on the North Metropolitan line. Was not that one of the main reasons why it was discontinued?—I do not know.

Mr. MOULTON: There was a lawsuit as to whose fault it was.

Mr. JUSTICE KEKEWICH: It is obvious, without any scientific explanation, that you might contract to have your house lighted to entertain your guests until two o'clock, and they might all be in the dark at one.

Mr. BOUSFIELD: The question is whether this liability does not interfere with its acting as a practical means of working. (To the WITNESS): There is always the difficulty with secondary batteries in the ascent of any gradient that the power available is very often not sufficient?—I do not know. I had not thought of that. You have not probably as much command as you have under other circumstances; but that, of course, might be met by gearing as in a bicycle.

As regards the power of the secondary system, that is a very large proportion of the total weight of the car?—Yes, I should say the weight was a very deterrent element.

Re-examined by Mr. MOULTON: With regard to testing whether your batteries have got sufficient charge, is that usual to do?—I think so.

With regard to the experimental tramway at Northfleet you have said it was experimental so far as the slot was concerned. Did that experiment enable you to say whether it was satisfactory?——Yes; certainly. I should be surprised to hear anyone come forward and say that they met with any difficulty whatever so far as the passage of the plate of metal through the slot was concerned.

With regard to the lines between telephone exchanges, the trunk lines, as they are sometimes called, is there a reason why they should be underground? Are they very numerous?—Yes; but I think very commonly you will find them carried in cables overhead.

If taken in cables either underground or overhead, is that a reason why they should be doubled?—Yes.

Mr. CHARLES LUPTON, examined by Mr. WARMINGTON, said he was a solicitor, living near the Roundhay Road, Leeds, and was one of the plaintiff's in the action. Until the defendants began running their electric cars the telephone service was very fairly satisfactory. But since that time it had become so difficult to use, that practically he never did use it unless someone wished to telephone to him professionally, when he made an effort to hear them; on many occasions he had been obliged to give up trying because he could not hear. He could hear a hum in the distance, which rapidly became more and more acute. It very often stopped and went on again. During a period when there was a break down in the defendants' works he could use the telephone as well as ever; when the cars started running again the noise was as bad as ever.

Mr. JUSTICE KEKEWICH here suggested that sometime during the Christmas holidays two gentlemen, one named by either side, should meet at Leeds and try several telephones when the trams were running and again when they were not running, and be prepared to give his lordship the result when the Court met again in January. Between persons representing such large interests there ought not to be the slightest doubt about this question of fact. The legal and scientific questions were two entirely different things. The facts ought to be beyond dispute.

Mr. BOUSFIELD: It is agreed there is some disturbance, and it is sometimes more than at others; whether it ever amounts to practical stoppage of communication is, of course, another thing.

After some further conversation upon the subject, Mr. BOUSFIELD said the parties would consider his lordship's suggestion.

Dr. THOMAS RICHARD JESSOP, a surgeon, of Leeds, gave evidence similar to that given by Mr. Lupton as to the interruptions to the use of the telephone, as also did Mr. ROBERT MIDDLETON, a mechanical engineer.

The Court then adjourned for the day.

THIRD DAY.—DECEMBER 15th.

Sir RICHARD WEBSTER: There is a small matter which I ought to mention to your lordship. In the cross-examination of Sir Frederick Bramwell yesterday, my friend Mr. Bousfield suggested somewhat confidently, no doubt on instructions, that the use of secondary batteries for working the Birmingham tramway system had been abandoned. We knew the facts, but we had no right to state them at the time. We communicated at once with Birmingham, and are prepared to bring up witnesses if necessary showing that it is a mistake, that they are still working, and that there is no suggestion of change.

Mr. BOUSFIELD: I do not want to put my friend to the trouble of proving it.

Sir FREDERICK BRAMWELL was re-called to give further evidence upon the question of providing for the difficulty of arranging overhead wires in the complicated case suggested by Mr. Bousfield. He put in a model of the arrangement; he suggested and explained it, and was cross-examined upon it.

Mr. REGINALD ALEXANDER DALZELL, manager, of the North Lancashire district of the National Telephone Company, examined by Sir RICHARD WEBSTER, said he was sub-manager of the Yorkshire district from September, 1891, to October, 1892. He had the practical management in consequence of the illness of the manager, Mr. Chambers, who had since died. The company's central exchange at Leeds was at Commercial Buildings, in the centre of the town, and there were branch exchanges at Chapeltown, Morley, Stanningley, and Headingley. There were altogether 1,200 subscribers, of whom about 1,000 were on the central exchange. The subscription was £10 a year. Leeds was connected by trunk lines with Birmingham, London, and practically with all the towns south in the country. Double wires were used between the long exchanges to make the lines perfectly quiet; and between the short exchanges, such as between Leeds and Headingley, and those places near, in order to join them to the long lines. The number of communications in the Leeds districts amounted to 18,000 a day. Up to October, 1891, the system worked satisfactorily, and complaints were few. The defendaut's tramway did not run in the centre of the town, but from two points in the suburbs to Roundhay Park. After the first day on which the defendants commenced running their electrical tramway, complaints began to come in, principally by telephone at first, but nearly everybody who had a connection in the Roundhay district wrote, and they also got complaints from people in other parts of the town, who wanted to get through to those subscribers. He did not think they could retain their subscribers, or gain new ones, unless they could improve the condition of the service.

Sir RICHARD WEBSTER: A suggestion was made which I think you happen to be able to say something about. I refer to the suggestion of taking a subscriber whose return earth would be affected by the tramway back to a subscriber at another distance, and allowing him to come back through that subscriber's wire. Would that cure the defect?—No, it would not cure it. I tried that, and whilst there was a slight improvement, it was nothing that would do any good. One knows also that that is not effective from practice on other lines. When we are working a loop line, it is absolutely necessary for us to have that line insulated throughout. If it is a wet day, and we get a contact with a wet branch of a tree, or something of that kind, the balance of the line, I cannot say why or how, is upset, and we get noise on that line immediately it is passing through an affected area, an area where there is any disturbance from outside causes.

Cross-examined by Mr. BOUSFIELD: It is your practice, is it not, wherever you run through a district where you find your earth return has been disturbed to use a metallic return?—Yes.

Why did you not carry out that practice in the present case?—Because it is not necessary. We do not do it for subscribers' lines. We have no affected areas except where we have these long lines through the country from town to town. I have never had to double a subscriber's line.

I suppose in your experiment you did not test for insulation?—No.

If the insulation was imperfect, the test would be valueless?—I do not know that it would altogether. I take it, taking the earth back there makes the insulation imperfect; you cannot get a balance on your line with the earth there.

At that time there was a great deal of snow, was there not? Was there not almost a breakdown of your system for some time?—There was a snowstorm, but there was not a breakdown. One or two loops were interfered with, but there was not anything like a breakdown.

Since this disturbance originally took place in Leeds, you have made certain alterations in your system?—None at all. We have made alterations just in the way of business, not in connection with this disturbance in any way.

Re-examined by Sir RICHARD WEBSTER: The alterations were made for the facility of getting better way-leaves and accommodating other subscribers.

Mr. DANIEL SINCLAIR, engineer and electrician-in-chief to the National Telephone Company, examined by Sir RICHARD WEBSTER, said he had had a very large experience of the effect of earthing a portion of a circuit where there was a metallic return, and he was able to say that that would not get rid of the difficulty from disturbances. He had gone through similar experiments to that described by Mr. Dalzell over and over again, because it was of immense importance to see if they could do what had been suggested. If they could have done that they would have overcome a difficulty that had cost them many thousands of pounds in erecting their switchboards. Snow had done serious injury to the telephonic system, especially in London, and an increase in the number of overhead wires would increase the liability to injnry from that source.

Cross-examined by Mr. BOUSFIELD: You probably know that in Stockholm the Government has insisted upon the whole of the wires being furnished with metallic returns?—I do not know that. What I do know is that when I was there in October of last year the large exchange had not metallic returns, but that the Government exchange had. The Government exchange at that time had about 600 subscribers, and the private exchange several thousands. The subscribers on the one exchange could communicate with the subscribers on the other, so that the metallic returns were capable of being worked in conjunction with the earth returns.

Then your experience teaches you that there is no practical difficulty in working a number of metallic returns in conjunction with a larger number of earth returns?—My experience does not teach me that there was no difficulty.

But it was done in Stockholm, and done successfully?—I cannot say it was done successfuliy.

Why not?—Because the fact of joining a loop on to a single wire introduces another piece of machinery. When that is used the speech is weakened.

It was done there with transformers, was it not?—I am not sure.

It was done by the same system that has been put to some of the witnesses of having a line partially single, and then doubled on itself?—All I can say is, if it is done that way it cannot be successful.

You are familiar with working an earth line in conjunction with a complete metallic line?—Yes; that is done by means of a translator.

The cost of these translators is about 9d. each?—No; it may vary from 8s. to 20s.

I suppose you are speaking of the translators used on your trunk lines?—Yes.

Would that be so for short distance connections such as I have suggested in Leeds?—The repeaters or transformers would be the same; we have only one class.

You can use a transformer which would be a matter of only a few pence?—I think not.

Re-examined by Sir RICHARD WEBSTER: If you get more than one of these transformers in a line, is there any difficulty in ringing up?—Yes; and they reduce the effective talking as well.

Berlin has one of the largest exchanges in Europe?—Yes; five of the largest exchanges in Europe exist in Berlin, and are all on the single-wire system. They belong to the German Government.

(To be continued.)

NOTES.

Malta Electric Lighting.—A *Times* telegram, dated Malta, December 30th, states that Mr. W. H. Preece had arrived there from London to confer further with the Local Government on the proposed installation of the electric light.

Taunton Electric Lighting.—Sir T. W. P. Blomefield, and Major Cardew, R.E., who held the recent enquiry at Taunton, have reported favourably, and the license has been granted.

Electricity on Prussian Railways.—The wish has been expressed in various quarters in Germany, so it is said, that the Prussian Railway Administration should make experiments with electric traction on one of the short lines.

Elektron Actien Gesellschaft.—Under this title a new company has been formed in Frankfort-on-the-Maine with a capital of £150,000 for the electrolytical production of chemicals.

Hull Electric Lighting.—The central station is to be formally opened by the Mayor on January 16th. The following day an electrical exhibition is to be opened to the public.

Runcorn Electric Lighting.—A proposal is to be made at the next meeting of the authorities that information be obtained as to the practicability and advisability of having an electric lighting installation at Runcorn.

Conditions under which Trees are Subject to Destruction by Lightning.—Mr. D. Jonesco has compiled statistics concerning trees which are struck by lightning, and arrives, says the *Electrical World*, at the following interesting conclusions:—It has been supposed for a long time that certain kinds of trees are particularly subject to destruction by lightning, while others are quite free from danger. Among the first is the oak, and among the latter the laurel. An investigation of this statement led that writer to the following conclusions:—"At very high potential electrical discharges all kinds of trees may be subject to destruction from lightning. Trees containing oils are less subject to be struck, those containing very much oil being protected the most. Lightning appears to prefer those trees which contain starch, and also those which contain oil to a slight degree only, in summer. The quantity of water contained in the trees has no effect on their liability to being struck. Dead limbs of trees, of those containing starch as well as of those containing oil are particularly subject to being struck. Cambium, bark and leaves, do not alter the conductivity of trees. The nature of the soil has no connection with the frequency of destruction of the trees by lightning."

A Simple Method of Finding Cross Connections in a Coil.—It is an easy matter says the *Electrical World* to find whether there is a cross connection between a coil and its core, but when the cross is between the wires themselves constituting the coils the usual method cannot be used. For such cases, as also for a number of others, a very ingenious and simple method is in use in the Thomson-Houston factory at Lynn, which is well worth the attention of those engaged in constructing apparatus containing coils in which cross connections may occur. It consists simply in placing the coil to be tested in the field of an alternating current coil and noticing whether or not parts of the coil become heated. It is evident that if there is a cross connection between the windings, the turns included between these points will form a short circuited coil in which currents will be induced when placed in this alternating current field, which will cause that portion to become heated. This method, therefore, not only shows when there is a cross, but, if there is one, it to a certain extent locates it. In some cases the coil to be tested is placed in the field with its core and in other cases without. For simplicity nothing more could be desired.

Storage Batteries for Central Stations.—This subject, and the opinions of Europeans relating thereto, is at present receiving no little attention among electrical circles in New York. According to the *Electrical World*, one of the Edison stations in New York is just about to connect a secondary battery plant to its mains. The batteries are of the Crompton-Howell type, composed of Planté elements of a highly porous lead, and in introducing this type in preference to pasted plates the best practice of European central stations has been followed. There are 51 plates to a cell, each about 8 inches square, and it is understood that 180 cells are to be employed, which, presumably, will give a capacity of over 1,500 ampère hours. The experience with this pioneer plant will be watched with great interest, and may lead to considerable remodelling in our continuous current central station practice.

South Staffordshire Electric Tramways.—On Saturday last the electric system of the South Staffordshire Tramway Company connecting Walsall, Wednesbury, Darlaston and Bloxwich was opened with befitting ceremony. The invited guests mustered at the generating station, James Bridge, and included ths Bishop of Lichfield, the mayors of Walsall, Wednesbury, and West Bromwich, and members of the governing bodies of the district, the chairman and directors of the company, and the directors of the Electric Construction Corporation. In the absence through indisposition of Sir D. Cooper, the chairman of this corporation, Mr. Irving Courtenay (deputy chairman) invited Mrs. Carruthers Wain, wife of the chairman of the Tramway Company, to switch on the current, which she did, Mr. A. Dickinson, the company's general manager and engineer, presenting her with a gold ring, bearing the emblems of Staffordshire, Walsall, and Wednesbury. The guests afterwards proceeded by the electric tram to Walsall, where luncheon was served in the Drill Hall, Mr. Wain presiding.

On Tuesday last a slight accident occurred to an electric car on The Bridge, Walsall. The first morning car was passing through Walsall from the depôt on the Bloxwich Road, and on reaching the sharp curve at The Bridge, where there is a junction of the Bloxwich and Mellish Road sections, a short length of wire snapped. The breakage took place close to the arm of the post, and the loose end of wire fell to the ground. The officials of the tramway company were soon on the spot, and temporarily adjusted the wire, thus restoring the connection, and again enabling the cars to run.

The Institution of Electrical Engineers.—The first of the meetings of this Institution during the remainder of the session 1892-93, will take place on Thursday, the 12th inst., when the discussion on the following paper will be resumed: "Experimental Researches on Alternate Current Transformers," by J. A. Fleming, M.A., D.Sc., F.R.S., Member. In consequence of the unavoidable absence abroad of the new president, Mr. W. H. Preece, F.R.S., on the 12th inst., he will deliver his inaugural address on the 26th inst.

Coast Communication.—In the interim report which the Royal Commission on Coast Communications has drawn up it is recommended, says the *Times*, that five lightships and a certain number of rock lighthouses shall be connected with the coast by telegraph cable. Those places will be selected which furnish the best opportunities for testing the possibility of such communication, and at the same time reveal the extent to which it is likely to be valuable in saving life or property. The £20,000 voted by Parliament last Session for erecting telegraph and telephone wires between coastguard stations, lifeboat stations, shore lighthouses, and rocket stations, has already been expended, and the reports of the Lifeboat institution show that, even in so short a period, the system has been the means of accelerating the despatch of the lifeboats to crews in distress and of saving several lives. Unfortunately, the funds now being exhausted, the work will have to remain at a standstill until the begining of the next financial year, when another grant will be asked for its continuation.

Telephone Statistics.—*Le Génie Civil* for December 31st, contains a very interesting article on the situation of the telephone in France during 1892. There are given the respective populations of the various towns referred to, and the total number of subscribers in each. A map is also given showing the proportion of subscribers to the total number of inhabitants throughout the whole of France.

Water Power.—The Bewdley Town Council decided on Monday last, to appoint a committee to consider and report upon the desirability of utilising the power of the River Severn for electric lighting the town.

The Institution of Civil Engineers.—Monday last was the seventy-fifth anniversary of the Institution of Civil Engineers—which was established for the advancement of mechanical philosophy—and which ten years later, was incorporated by Royal Charter under great seal. It consists to-day of 5,122 corporate members, 389 associates, and 830 students, together 6,341, exhibiting a steady and continuous growth.

The Tramways' Institute.—A meeting of the council of the Tramways' Institute of Great Britain and Ireland was held last Friday at Birmingham, Mr. Carruthers Wain presiding. The chairman remarked upon the progress that had been made within the past six months in tram traction. Mr. Alfred Dickinson read a paper on the South Staffordshire overhead electric traction line, which was opened last Saturday. A vote of thanks was accorded to Mr. Dickinson, and the council inspected the installation of the South Staffordshire system on Saturday.

Dundee Electric Lighting.—There is a suggestion before the authorities at Dundee, to light the harbour and docks by electricity, and to consider the desirability of running an electric car from West Station to the cattle depôt.

Complaints are being made as to the bad lighting of the Dundee Guildhall, but the question has been postponed until the effect of the introduction of the electric lighting into the Town House has been ascertained.

The necessary plans and specifications are being drawn up for the electric lighting of the Town Hall and City Chambers. The last of the boilers for the electric lighting stations has been delivered, and the other machinery is being fitted up as speedily as possible with the expectation of having everything in motion by the fourth week in this month. An application by Messrs. Cox Bros. for an extension of electric lighting mains to their office has been granted.

Chicago Exhibition.—The Royal Commission have issued the fourth edition of their "Handbook of regulations and general information," which is destined to be of great value to intending visitors to Chicago during next year.

Dundalk Electric Lighting.—The Dundalk Gas Company object to the Borough Surveyor being appointed gas examiner on the grounds that he will not be an impartial person. This action is considered as a further reason for the efforts to obtain renewal of the electric lighting provisional order.

Harrogate Electric Lighting.—A bill, lately deposited in the House of Commons, seeks powers for the acquisition of specified land, the erection of generating and such other works necessary for the supply of electricity, and the laying down of mains, &c.

Bath Electric Lighting.—The electric lighting is said to be defective and irregular, and frequently extinguished. The Lighting Committee have the matter in hand, to discuss the best steps to take to remedy the defects.

Paisley Electric Lighting.—No decision has yet been come to by the Paisley Corporation regarding the electric lighting tenders. The matter has been postponed for six months.

Matlock Electric Tramway.—There is a movement in the Matlock district for the promotion of a company for erecting an electric tramway service between the Bath and the Bridge. The speculation is expected to be a private one.

Brighton Electric Lighting.—In order to give a fillip to the use of the electric light at Brighton, the Lighting Committee of the Town Council have recommended a reduction, to date from the commencement of the new year, in the charge for electricity to consumers who keep their lamps burning on an average more than two hours per day throughout the year, as follows: For the first two hours, 7d. per unit, after the first two hours, 3½d. per unit.

The Manchester Telephone Service.—The following is from the *Manchester Mail* of 31st ult.:—"After to-morrow the telephone trunk line business of the National Telephone Company and other companies will be taken over by the Post Office authorities, and with regard to the use of the lines by the public a new system will be inaugurated. The old arrangement of payment of a yearly rental will disappear, and over both Post Office trunk lines and trunk lines of the National Company there will be substituted a payment for each conversation of three minutes' duration at a minimum charge of 3d. The cause of the change, as set forth in a Treasury minute, is that it is impossible to continue the present system, under which the telegraph revenue is seriously suffering, whilst on the other hand the extension of telephones is checked in a manner which cannot be permanently maintained."

Cheltenham Electric Lighting.—The adjourned discussion regarding the adoption of an electric lighting scheme was resumed on Monday last, when the matter was referred back to the Electric Lighting Committee for them to obtain further professional advice upon the scheme recommended.

Our Share List.—In our share list of electrical companies, on page 22 will be noticed a deviation from our general rule. There will be observed in the last right-hand column the highest and lowest prices at which business has been done in the various companies' shares, on the Stock Exchange, during the year just ended.

Montreal Electric Lighting.—The contract of the electric lighting at Montreal has been placed with the Royal Company. For the first five years this company is to receive $124 per lamp per year, $120 for the next three years, and $116 for the last two years. The loss to the city, says the *Montreal Gazette*, on the present basis will be $212,000, or over $21,000 per year. That is calculated on the basis of 1,000 lamps without allowing for increases in the number of the same which is very probable.

Electric Lighting at Arbroath.—Letham Grange Mansion House has been fitted with a complete installation of the electric light at a cost of over £2,000. The mansion house, stables, riding school, dairy, and all the buildings, excepting the workmen's houses, have been lighted throughout. The boiler is a Babcock and Wilcox, and the accumulators were supplied by the Electrical Power Storage Company.

Portsmouth Electric Lighting.—The electric light installation at Portsmouth, says the *Hampshire Chronicle*, is expected to be completed by the month of September, and about a fortnight hence tenders for the construction of mains, transformers, boilers, engines, street lamps, &c., will be opened.

Australian Telegraph Rates.—The *London Gazette* for Tuesday last contains a list of the revised rates for telegrams to Australia and New Zealand. The rates to New South Wales, South Australia, Victoria, Western Australia and Tasmania have been raised, whilst a reduction has been made in the rates to New Zealand.

The Clapham and Paddington Railway.—Several critics of the Clapham and Paddington Subway Railway scheme have been writing letters to the *Times*. The scheme has been condemned by one of these, by the statement that it would not do to have trains converging on Kensington Gardens from all parts of the County of London, as it would reduce the value of landed and house properties in that vicinity. When this railway was proposed in 1891, the subject called forth a good deal of public discussion, and much alarm, says a *Times* correspondent, was felt regarding the threatened injury to Kensington Gardens, with the result that the Bill was withdrawn after the second reading. "Londoner" considers that the subway being erected 50 feet below the gardens will do great injury to the trees, which, says he, are already much damaged by what has been done underground. The saving and protection of these trees, he considered, must be thought of more than the laying down of a railway which would undoubtedly be a great public convenience.

Lectures.—A course of twelve special practical lectures are to be delivered at the School of Electrical Engineering, Princes Street, Hanover Square, W., by Mr. E. Tremlett Carter, commencing on Tuesday, January 17th. The subject to be dealt with is "Prime movers for electrical engineering." We understand it is the lecturer's intention to deal with prime movers in relation to central station work on all systems, and for electric railway work also.

Heckmondwike Electric Lighting.—The Town Clerk has been empowered to take the necessary steps for obtaining the consent of the Board of Trade and the sanction of the Local Government Board to the electric lighting scheme. The question of employing an engineer to prepare plans &c., and his remuneration is to be discussed in committee.

Cardiff Electric Lighting.—It is expected that a Local Government Board enquiry will be held shortly regarding the electric lighting scheme which the Cardiff authorities have submitted.

Southport Electric Tramways.—The Town Council has adopted a scheme which comprises the erection of an electric tramway to run along a new drive which is to be made, joining the two marine lakes.

Scarborough Electric Lighting.—Further steps have been taken by the recently formed Electric Lighting Company in the matter of introducing electricity for lighting the town. About two acres of land have been purchased by the company. Preparations are also being made for the erection of the station.

Society of Arts.—On Friday, January 13th, Prof. W. Cawthorne Unwin, F.R.S., will deliver the first of his course of Howard Lectures. Subject: "The Development and Transmission of Power from Central Stations."

Galway Electric Lighting.—The electric light is gaining ground in Galway. Amongst the establishments lighted by electricity are—The Colonial Buildings, the Eglinton Buildings, Mr. Martin Jordan's, Mr. Thomas Dillon's, Mr. Henry Cloherty's, and Messrs. Jordan & Sons. The light is also used in several private premises, and has, up to the present, given entire satisfaction.

The Nature of the Slag in Electrical Furnaces.—In the manufacture of phosphorus from a mixture of natural aluminium phosphate, calcium phosphate, carbon and sand, in an electrical furnace two kinds of slag are obtained: the predominating one consists chiefly of calcium and aluminium silicates; the other, apparently a mixture of iron silicides and phosphide in varying proportions has recently been found by Mr. J. C. Chorley to contain from 68 to 74 per cent. of iron, 9 to 14 per cent. of phosphorus, and 10 to 19 per cent. of silicon. This slag is found distributed through the mass in very hard brittle buttons which conduct electricity well. Some of our readers may be interested in the electrical process of preparing phosphorus and they will find the paper by Mr. Chorley, in which he describes his work on these slags, in the *Chemical News*, lxv., pp. 301-302.

Manchester Electric Lighting.—The wires are now being put up in the Manchester Town Hall for the lighting by electricity.

Sowerby Electric Lighting.—The Lighting question is before the authorities at present.

NEW COMPANIES REGISTERED.

Dalziel's Atlantic Telegram Company, Limited.—This company was registered on the 29th ult. with a capital of £25,000, in 250 shares of £100 each. Objects: To carry on the business of agents for any telegraph or cable company for the collection, transmission, and delivery of messages of a private or commercial character, and which are not intended for publication in any journal, or for circulation in any manner; and to carry on any business in connection with the above other than that of a press, public, or private agency, or advertising agency. The subscribers (with 1 share each) are: D. Dalziel, 222, Strand, journalist; W. C. Hallett, 7, St. Martin's Place, banker, &c.; M. Hallett, 7, St. Martin's Place, W.C., banker, &c.; W. F. Jackson, 31, Harrington Gardens, S.W., electrical engineer; T. Akers, Alledandon Road, S.E., agent; T. Whittaker, Maida Vale, secretary; J. T. Glass, St. Peter's Park, W., solicitor's clerk. Unless otherwise determined by a general meeting, the number of directors is not to be less than two nor more than seven; qualification, £100; remuneration, £150 for the chairman and £100 per annum for each director, together with percentage on profits. Registered by Burton, Yeates, and Hart, 23, Surrey Street, W.C.

Bridgeholme Wadding Manufacturing Company, Limited.—This company was registered on the 31st inst. with a capital of £3,000, divided into 300 shares of £10 each, to acquire and take over the Mill Cottages land and premises belonging to Mr. John Smith, situate at Bridgeholme Green, Chinley, in the parish of Glossop, Derby, and to carry on the businesses of cotton wool, wadding, swansdown and buckram manufacturers, dyers, bleachers, paper manufacturers, producers of electrical light and power, &c. The subscribers (with 1 share each) are:—J. C. Ashwell, Stockport, engineer; T. Smith, Chapel-en-le-Frith, ironmonger; J. W. Smith, Weston-super-Mare, physician and surgeon; G. Howe, Buxton, veterinary surgeon; Ada M. A. Smith, Chapel-en-le-Frith, spinster; S. A. Howe, Buxton, veterinary surgeon; F. G. A. Smith, Chapel-en-le-Frith, spinster. Registered, without articles of association, by Jordan and Sons, 120, Chancery Lane, W.C. Registered office, Chinley, Derby.

African Transcontinental Telegraph Company, Limited.—This company was registered on the 27th inst. with a capital of £140,000, in £1 shares, to construct telegraphs anywhere on the continent of Africa; to carry on the business of a telegraph, telephone and electric light, heating and power supply company; and to regulate telegraph and telephone exchanges and works for the supply of electric light. The subscribers (with one share each) are:—E. M. E. Smith, 253, Cromwell Road, S.W., clerk; J. F. Jones, Forest Hill, S.E., clerk: R. C. Bolton, Crouch End, N., clerk; C. W. Chandler, Brixton, S.W., clerk; A. E. Jowett, St. Albans, Herts., clerk; M. A. Shaughnessy, 33A, Kennington Lane, S.E., clerk; Ed. Pryer, High Barnet, clerk. Registered, without articles of association, by Hollams Sons, Coward and Hawkesley, Mincing Lane, E.C.

CONTRACT CLOSED.

Dundee.—Messrs. Mather & Platt's tender for the station engine and dynamo at £283 has been accepted.

BUSINESS NOTICES, &c.

Paterson & Cooper.—Notwithstanding the somewhat depressed condition of the electrical engineering trade, Messrs. Paterson & Cooper have succeeded in securing a fair share of work. In ship lighting, which is one of their specialities, the following work has been done:—The ss. *Carthaginian* for the Allan Line, the *Empress of the East*, steam yacht *Vanduara* for Stewart Clark, Esq.,. Paisley, the Clyde Shipping Company's steamers *Sanda*, *Dungeness* and *Longships*, the ss. *Cuidad de Cadiz*, built by Messrs. Lobnitz, of Renfrew, the new ss. *Peregrine*, of the General Steam Navigation Company, the North of Scotland, Orkney and Shetland Steam Navigation Company's ss. *St. Giles*, and the training ship *Shaftesbury*. Of ships in hand there are at present the ss. *Polynesian* of the Allen Company, the ss. *Princess Beatrice*, Messrs. Langlands and Co., Liverpool, and the ss. *Matin* for Messrs. Mudie and Sons, of Dundee. A number of direct driving sets and other ship lighting plant have been supplied for vessels wired by other firms and for vessels built abroad. A fair amount of installation work has been done, the principal being for Messrs. Gregory and Sons, Royal Mail contractors, Jersey, Messrs. Lipton's establishment at Southampton, the private residence of E. Cox, Esq., Cardean, Perthshire, the Royal Mail Steamship Company's offices, the Imperial Ottoman Bank, Union of Canton Insurance Company, &c. The large installation at the *Daily Chronicle* offices has been finished, and extensions are being made to the 1,600-light installation at Messrs. Nelson & Co.'s refrigeration stores and wharf, a number of motors for ventilation having been erected. The principal installations in hand are Messrs. Lipton's establishment, Glasgow, Messrs. Workman, Clark & Company's shipbuilding yard at Belfast, the Eastern Club, Dundee, the Northern Assurance Company, Dundee, the Market Hall, Hull, and the private residence of H. W. Buddicom, Esq., Penbedw, Mold. In manufacturing departments a fair average has been maintained. Although somewhat below last year, the output of dynamos has been satisfactory, A considerable business has been done in measuring instruments several large orders having been received from abroad. The output of arc lamps, switchboards and general electrical apparatus has also been fairly maintained. The following is an account of installations carried out by Messrs. Paterson & Cooper during the year 1892: Complete installations: Messrs. Mowlem & Co., Lacroute Works, Guernsey; the new floating bridge, Portsmouth; Broad Street House, Old Broad Street, E.C. Installations in the City, supplied from the City of London Supply Company, Limited:—Messrs. Brown, Shipley and Co.; the Colonial and Mutual Insurance Company; Messrs. Bullard, King & Co.; Messrs. Alexander, Lawrie & Co.; the China Traders' Assurance Association; Messrs. Pollard & Co.; the Sea Insurance Company, and Messrs. Willis & Co.; the Union of Canton Insurance Association; Messrs. Parker & Thomas; United States Lands Investment Company; the Salvation Army Headquarters; Royal Mail Steam Packet Offices; the Imperial Ottoman Bank. Supplied from the Metropolitan Company:—F. Austin, Esq., Messrs. Collett & Co., Jas. Walker, Esq., Isambard Brunel, Esq., Baker's Hotel, the New Victoria Concert Hall. Supplied from the Westminster Company:—J. T. Drew, Esq., Messrs. Hudson, the Hon. T. R. Vernon, Colonel Ollivant. Supplied from the House to House Company:—Chas. Goolden, Esq., Dr. Tyrrell, Dr. Gorden, R. E. Noble. Esq. Supplied from the London Electric Supply Company:—Messrs. Lipton's, Messrs. Morris & Co., Messrs. Sedgwick & Co. Supplied by the St. James's and Pall Mall Company:—W. Bald, Esq.

Messrs. Drake & Gorham.—Although, as a natural consequence, the electrical trade has, in some degree, felt the general commercial depression during the past year, this firm have not much cause for complaint judging from the list of work carried out by them for this period, for the number of installation contracts obtained during 1892 reaches a total of 96 or very nearly two per week throughout the year, the number of lights installed being upwards of 10,000. We also note that further improvements have been effected in the D.P. battery which has now been before the trade for over three years, and they are spoken well of by contractors. The instruments manufactured under the Cardew patents, of which this firm are the owners, have as usual commanded a large sale, the voltmeter and earthing device having been sent out in large quantities during the year. The new recording instruments lately introduced by Messrs. Drake & Gorham, working in conjunction with Captain Holden, are also coming into favour, and more especially is this the case with the photographic type, which entirely eliminates any error from friction. The electric hoists put down by the firm some years back continue to give every satisfaction, and a passenger and luggage lift is now being installed at Callaly Castle, Northumberland, in connection with the electric light installation put down by the firm. This contains all the latest improvements and will be driven by a 6 H.P. motor. During the year the electrostatic indicator, to comply with the requirements of the Board of Trade and patented by the firm, has been improved to such an extent that the insulation resistance of either of the high tension mains can be read at any time, this being one of the cheapest instruments in the market for this purpose. The firm have installed several petroleum engines both of Messrs. Priestman's and Crossley's make, two of the former being 11 H.P. each. These engines are working satisfactorily and will no doubt be in greater demand during the present year.

Price Lists, Calendars, &c.—We have received a copy of Messrs. Crompton & Co.'s new price list of dynamos, generators, and motors. It is noticeable on examining the prices set down, that in almost every case reductions have been made. Messrs. Crompton have made the list very complete, and we believe it will be of great use in the market for direct current dynamo machines. The book is shortly to be supplemented by a complete catalogue embracing all the company's other manufactures. We cannot refrain from saying that the book is really beautifully and clearly set out, the printing being clean and nice, and the illustrations also very clear. In the front of the catalogue is a useful telegraph code, and the other parts of the book are divided off into tables. The table to the first section gives prices and many details regarding dynamos for incandescent lighting, with or without batteries. The dynamos under this first table are, we understand, equally applicable to other purposes besides that of incandescent lighting, and Messrs. Crompton have supplied them with great success for many purposes, such as electro-deposition of copper, electro-chemical processes, and electric welding. The table to the second section enumerates prices and detailed information of series-wound dynamos for arc lighting, 300 to 2,000 volts. In connection with this section 2 there are some explanatory notes on Crompton generators and motors for the transmission of power, &c. Table 3 is a priced and otherwise particularised list of these generators and motors. Table 4 deals in a similar manner with Crompton motors for working on incandescent circuits, along with some explanatory notes on the motors. Other dynamos are shown, and a number of testimonials appear at the end of the book, which, on the whole is a well got-up and useful catalogue.

Messrs. Ludw. Loewe & Co., have brought out several neat lists containing descriptions and illustrations of machine tools. These we understand are the advanced sheets of a new catalogue which the firm are now preparing. Hand and power milling machines, die-sinking machines, profiling machines, &c., are be dealt with.

The Commercial Cable Company have sent us the season's greetings in the form of a photograph of their offices at the corner of Wall and Broad Streets, New York, as they appeared on the occasion of the Columbus quadri-centennial decorations, 1892.

Messrs. W. H. Willcox & Co., engineers' stores suppliers and oil refiners, of Southwark Street, have sent us a copy of their 1893 date remembr ancer, and lists of their cylinder, &c., oils.

The Amber File and Index Company, of Little Britain, have sent us a set of their small blotters.

The Eastern Telegraph Company, Limited, have, as usual, sent us one of their calendar paper knives for 1893.

Brussels Electric Light Station.—We understand that the contract between the India-rubber, Gutta Percha, and Telegraph Works Company and the Brussels town authorities, has now been signed. This, however, has only been done after a close examination extending over some considerable time. The chief feature in the scheme lies in the plan of distribution, the cables throughout being insulated with vulcanised India-rubber, and run in separate cast-iron pipes, this system being adopted in preference to others on account of immunity from possible breakdown and consequent high cost of maintenance, most essential points, which had the full consideration of the town authorities, who fortunately did not decide on the question of first cost alone—an example which could be followed with advantage by other wealthy towns that can obtain money at a cheap rate and are willing to exercise some foresight in such an important matter. The station, when completed, will have six units of 500 H.P. each, any one unit—if required as a reserve, or for exceptional loads, for a short time—being capable of working up to 625 H.P. The battery of accumulators will eventually be increased to 1,250 16-C.P. lamps normal load. Pioneer installation—Site: Eglise St. Catherine, Place St. Catherine, near the Boulevard Anspach. Boilers: Three boilers, safety multitubular, 226 square metres' heating surface each, with pumps and economisers complete. Engines: two horizontal, compound, condensing, Sulzer type, by Carels, of Ghent, 500 H.P. effective, but each capable of working up to 625 H.P. effective if required. Dynamos: Four slow-speed multipolar with a rope drive, two to each engine. Switchboard: arranged for 24 circuits, on the three-wire system, with feeding centres. Accumulators: 140 elements, special construction, with ample clearance, for a normal load of 625 16-C.P. lamps, arranged for easy examination. Distribution: three-wire, each cable insulated throughout with vulcanised India-rubber, and drawn into separate cast-iron pipes. Distributing mains each side of road from centres, which are connected to central station by feeders and pilot wires. The installation is to be in complete working order by October next. Current is to be sold by meter. The Silvertown Company have to work the station for two years after delivery, to the satisfaction of the town.

Rosling and Matthews.—Messrs. Rosling and Matthews, electrical engineers, of Trafalgar Works, Bradford, have been very full of work for some time past. They have fitted up the foot-lights and side lights of the Theatre Royal, Bradford, with three rows of electric lamps—red, green, and white—the current being turned on to any one of these by means of a three-way switch. The lighting is giving universal satisfaction. The generating plant is in their own works, which adjoins the theatre. They have also a large number of machines (dynamos and motors) on order, ranging from 1 to 30 units in size; the majority of these are for the trade, this being a branch of the business they are now specially cultivating.

St. Austell Electric Lighting.—The Assembly Rooms at St. Austell have recently been fitted up with the electric light. In the centre of the roof is an incandescent lamp of 1,000 C.P., and round the room are others, making the total 1,500 C.P. The light is supplied from the works of Messrs. J. E. Veale & Co., Limited.

Crompton-Howell Electrical Storage Company.—The following is a brief summary of the most important works which the Crompton-Howell Electrical Storage Company have undertaken during the year:—McGill University, Montreal, 120 cells capable of discharging at 200 ampères each; Glasgow Corporation, 120 cells, 600 ampères each; Hull Corporation, 120 cells, 300 ampères each; central lighting station of Oporto, 60 cells, 300 ampères each; Hove Electric Lighting Company, 118 cells, 200 ampères each; Blenheim Palace, 104 cells, 200 ampères each; J. C. Howell, 54 cells, 200 ampères each; Oldham Corporation, 67 cells, 300 ampères each; Crompton Supply Co. of Australia, 50 cells, 300 ampères each; Edison Co., of New York, 120 cells, 500 ampères each; Pretoria Co., 144 cells, 600 ampères each; J. C. Howell, 120 cells, 600 ampères each. In addition, the company have supplied to the customers given below over 1,000 cells of various sizes, which it would be beyond the scope of this brief summary to recapitualate in detail; the company, it seems, have been extremely fortunate during the last year in having no trouble with regard to renewals or repairs of batteries:—Fowler, Lancaster & Co.; Chamberlain and Hookham; Interior Conduit Co., of New York; Ferranti and Co., Ltd.; Beavor Webb; H.M. Dockyard; Western Counties Electric Lighting Co.; Hicks, Esq.; Laurence, Scott & Co.; Crompton and Co., Ltd.; Prof. O. Lodge; Prof. Carey Foster; J. C. Howell; Lloyd & Lloyd.

An Interesting Installation.—The Electro-Medical Apparatus Company have lately completed an interesting installation at their premises, Trafalgar Chambers, St. Martin's Lane, W.C. The Apparatus Room has been fitted with 16 C.P. Edison-Swan lamps, and a wall-plug for connecting with apparatus when required. The Treatment Room is similarly fitted, but has, in addition, an adjustable lamp with counterweight and pulley suspended over the operating chair, and a special reflecting hand-lamp, fed from a wall-plug, for illuminating small cavities when under examination or treatment. Here is also fixed an arrangement, designed by the managers, and called the L.K. current controller, which enables the current from the light circuit to be used for treatment with perfect safety and convenience. The current passing through this apparatus can never be large, as a magnetic cut-out, set at 500 ma., is used, instead of an ordinary fuse. Such portion of this current as may be required reaches the patient through a shunt circuit, and can be regulated, without a break from 1 to 100 ma., by means of an adjustable resistance. Another interesting feature in the room is an arrangement of coil and proper insulators for the treatment of patients by Laurence's modification of Tesla's "unipolar" method. The Bath Room is also fitted with incandescent lamps, and by means of a wall-plug has the current laid on to an electric bath, an electric douche, or an electro-gymnastic apparatus, as occasion may require.

Presentation.—An interesting meeting was held at the offices of the Great Western Railway Company's Telegraph Department on the 28th ult., to present Mr. C. E. Spagnoletti, the late chief electrician to the G.W.R. Co., with a testimonial upon his retirement from active service. The presentation consisted of a handsome illuminated address and several valuable articles of plate, subscribed for by the members of the telegraph and electric light departments. The chair was taken by Mr. H. T. Goodenough (Mr. Spagnoletti's successor to the position of chief electrician), who gave a short account of Mr. Spagnoletti's work in connection with the Great Western Railway.

Ogmore Valley Electric Lighting.—The Ogmore Valley Electric Light and Power Supply Company have recently carried out the electric lighting at Nantymoel, Tynewydd and the district around. On 19th ult., 144 public and a large number of private lamps were lighted for the first time and gave entire satisfaction. The total number of lamps proposed to be installed at present is about 700. The demand for private lighting is said to be exceedingly satisfactory. Mr. George Wilson, of Brynhyfryd, Aberdare, was consulting electrical engineer to the company, for the work.

Business Alterations.—The Stockton Forge Company have terminated their connection with Mr. S C. Shewell (formerly their agent) by mutual arrangement. The company have also removed their offices from Suffolk House, Cannon Street, E.C., to 20, Victoria Street, Westminster, S.W. Mr. W. S. Atkinson, recently in charge of the drawing office at the works at Stockton, will be the resident representative.

Kimberley Exhibition.—Among the awards granted at the Kimberley Exhibition in South Africa was one of a silver medal to Messrs. Woodhouse and Rawson United, Limited, for electric light fittings, of which we understand they made a first-class display.

B. Verity & Sons.—Messrs. Verity, electrical engineers, have just completed the laying down of a plant for electric lighting at Hunton, Kent. The work has been carried out under the supervision of Mr. W. Galpin and Mr. Coles.

Dudley Electric Lighting.—Applications for leave to tender for electric lighting Dudley have been made by the Brush Electrical Engineering Company, and also by Messrs. Siemens Brothers, Limited.

Industrial Exhibition Electric Lighting.—The electric lighting for the St. Michael's (Shrewsbury) Industrial Exhibition was supplied by Messrs. Lea, Sons & Co.

Partnership.—Mr. C. D. Monninger, of St. Anna Work's, Clerkenwell Road, has taken into partnership his son, Mr. H. F. C. Monninger. The name of the firm will remain unaltered.

Mansion Electric Lighting.—Messrs. A. Hall & Co., of Liverpool, have just secured the contract for lighting by electricity Nannau Hall, situate two miles from Dolgelly, which belongs to John Vaughan, Esq., J.P. The generating station will be one mile from the mansion, water being the motive power, viz., a 1·35 horse-power horizontal turbine fitted to drive two dynamos capable of maintaining 200 16-candle-power glow lamps, the conductors to carry the current will be highly insulated copper cables suspended on pitch pine posts; the mansion is to be fitted with about 120 lamps, and it is intended the remainder shall be used for illuminating Nannau church, parsonage and schools. The same firm have just completed the electric lighting of Dolgelly, the motive power in this case also being water, the plant consisting of two horizontal turbines of 67 horse-power, two dynamos capable of supplying 800 16-C.P. glow lamps, also a 20 H.P. steam engine and one dynamo; this plant will only be used in case of a failure of the water power, which is not anticipated. The electric light is progressing in Dolgelly; most of the hotels and shops, and many private residences, are already electrically lighted.

Electric Light in the City.—A good number of new contracts are to be noted in the City district. Since our last report we observe that Messrs. Laing, Wharton & Down are engaged in Sydney Chambers, Leadenhall Street. This firm have also contracts in hand at 22, St. Mary Axe, and one at 6A, Austin Friars. Electric lighting work has recently been completed in the premises of Messrs. W. and A. Isaacs, of Old Broad Street.—Messrs. McClellan & Co., of Ludgate Hill are fitting up electric light in the branch establishment of Messrs. Dolland, in Old Broad Street.—Messrs. F. Suter & Co., are engaged upon electric lighting work at 16, Old Broad Street.—A contract is being carried out in Austin Friars Chambers, Austin Friars, by Messrs. Croggon & Co.—Messrs. Wenham & Waters, Limited, are at work at 26, Austin Friars.—The Brush Electrical Engineering Company are carrying out a contract in the offices of the Palatine Insurance Company, Cheapside.—Electric lighting work has also recently been completed in the premises of Messrs. Kendal & Dent, Cheapside; and Messrs. Miller & Woods, electrical engineers, have completed the fitting up of their premises at 2, Gray's Inn Road, Holborn,

Personal.—Mr. W. F. Collins informs us that he has resigned the position of western editor and manager of the New York *Electrical Engineer*, and has associated himself with the *Western Electrician* of Chicago.

Mr. Lester Betts, electrician to the Calcutta branch of the India-rubber, Gutta-Percha and Telegraph Works Company (son of the late J. W. Betts), has just returned home to recruit his health, having been two years in Nepaul, fitting up large electric light plant for the Government, to whom his services were lent by the India-rubber Company.

CITY NOTES.

Elmore's Patent Copper Depositing Company, Limited.

THE third annual ordinary general meeting of the shareholders of Elmore's Patent Copper Depositing Company, Limited, was held at the Great Northern Hotel, Leeds, on Friday afternoon. Mr. J. Jepson Atkinson presided, and there was a moderate attendance of shareholders. Mr. Terah Hooley and Mr. Wm. Goode Johnson (directors), Mr. Hays (of Messrs. Hays, Schmettan & Ancrum, of Abchurch Lane, E.C., solicitors to the company), and Mr. S. Elmore were also present.

The CHAIRMAN moved the adoption of the report and accounts. In speaking to his motion he said a word of explanation was perhaps necessary as to why they were holding their general meeting this year at Leeds rather than in London, where they had been held hitherto. Some shareholders had thought that that *locale* had been adopted in order to avoid meeting the members of the company, but he need hardly say that that was certainly not the case, as they had, he thought, approximately, as many shareholders in the north as in the south. In meeting at Leeds the Board wished to emphasise the fact that the company was a Leeds industry, that its offices were at Leeds, and that the Board meetings were and had for some time been held at the works, in order that the directors might be personally and immediately conversant with what was being done. It was, therefore, appropriate that their general meetings should be held there, so that their shareholders might have an opportunity of seeing their property and works, and of forming an opinion for themselves of the position and prospects of the company. They were aware that the accounts submitted to them were for the year ended June 30th last, a period which, as mentioned in the report, was chiefly occupied in completing the machinery and plant. The last six months of this period were disappointing to him as well as to themselves, all having sincerely thought that every difficulty was overcome at the end of 1891 when they last met. However, he frankly admitted that he shared their disappointment with regard to the working of the company for the period in question. But he wished at the same time to point out what appeared to him to be a very satisfactory feature in the accounts; namely, that they showed a profit derived from the company's trading to the extent of nearly £800; notwithstanding the fact that the output for the whole of the year under consideration did not reach more than 5 per cent. of what the plant was laid down to turn out. They might, therefore, easily calculate that if so small an output brought in so large a profit as that, after meeting the whole expenses properly chargeable to the trading account, then, with an output of 15 or 20 tons a week, a very much larger rate of profit would be secured. In this connection it was to be noted that the most productive sources from which they anticipated orders and large profits, such as the manufacture of steam pipes, had not yet been entered upon by them, although they were taking immediate steps to accept orders for these, as stated in the report. They might take it from him that the steam pipes, in point of satisfaction to customers and profit to the company, would leave nothing to be desired. He might also say that profit and loss had been debited with some items which next year would not appear, or, if they did, would be considerably reduced, and, moreover, considering the very little wear and tear to which the plant had been put, they had written off a very large sum for depreciation and maintenance of plant. The directors were taking no fees until the shareholders had received a dividend. He wished very strongly to impress upon the shareholders that notwithstanding the many vexatious difficulties which they had had to overcome, and the long delay in realising some of their anticipations, yet the Elmore process, as an electro-metallurgical operation, was perfectly successful. They continued to receive a large number of repeat orders, and customers were perfectly satisfied with the deliveries. The shareholders must not for one moment think that the process was a failure, and the directors were perfectly certain that in the course of the coming year they could prove every statement they had made as to its success. In palliation of their own difficulties, he might refer his hearers to such companies as the Bessemer Steel Company, Brunner Mond & Co., the Credender Tube Company, and others, which to-day were a great success and which in the early stages of their development presented the same grounds of disappointment as they had to-day; but which, nevertheless, had achieved remarkable success by dint of hard work and perseverance. And they themselves, having a perfectly sound monopoly in their hands, were determined by the same means to secure a similar success, and their confidence in that respect could not be better seen than by an inspection of the shareholders' register, which would show that the directors and officials of the company, and their immediate friends, held a very large proportion of the company's share capital. Since June 30th, a reconstruction of the board of directors had taken place, and two practical commercial gentlemen, who had been in business all their lives, and one of whom, after investigating the process and seeing the works, finding out all he could, had invested something like £20,000, and had joined the board. Those gentlemen had now got to work and, as they said, they would make a success of it. He was himself the chief shareholder formerly, but Mr. Hooley beat him now. He (the speaker) stuck to his shares when they were at a very high premium and he was sticking to them still. There was no question the price they could get for their work was as good as they ever said in their prospectuses or in any of their reports. The quality was good and the only thing was, there had been delay. Mr. Elmore, their general manager, was there and he would like the shareholders to see him and get as much as they could out of him about the business before leaving Leeds. He moved that the report and accounts be received and adopted, and he would like Mr. W. Johnson, one of their new directors, to address some observations to those shareholders present.

Mr. W. G. JOHNSON seconded the motion.

Mr. HAWKYARD said he thought it was the duty of the shareholders to fairly criticise the directors. His criticism that afternoon would be of a very mild character. He thought the directors had been working hard to make the company a success, and he had no doubt that, as a commercial undertaking, it would eventually be a success. He thought not only the directors needed their sympathy, but the shareholders also, and no doubt many shareholders would have been glad if the directors had been able to report that there was some little dividend due upon their shares. There were several items in the balance-sheet which, if he were hypercritical, he might comment upon, but that was not his object. He thought the shareholders ought to be satisfied that they had a director who, after full enquiry, had invested so large a sum as £20,000 in the company. He noticed that there was an amount set down as an asset of £80,000 for patents. That was a large item, and although that stood there, they had on the balance-sheet an adverse balance of £8,566 to make up. He was glad the board were sanguine they would be able to make that up. He also found that there was a very small balance at their banker's, and, looking at the amount due to creditors, he thought they ought to have had a larger amount at the banker's. He believed the concern would be made a successful one, and therefore he had much pleasure in supporting the motion.

Mr. SQUIRE, as one of the London shareholders, disclaimed any hostility to the directors. Mr. Balfour, at Manchester, described the Conservative party as a party of dividends, and the Liberal party as always issuing prospectuses; and, if that were so, the Elmore Company had justified a claim to Liberal orthodoxy, and were free from any taint of Conservative heresy. (Laughter.) He thought the time had arrived when the shareholders ought to know where they were going, and what their prospects were. He made an attempt himself some time ago to get a little behind the scenes, and see what the prospects of the company were likely to be. Some shareholders suggested that he, as an engineer and chemist, should visit the works, and he wrote to the secretary asking if that would be agreeable. The secretary wrote back saying that, owing to the number of similar applications, and the amount of time the manager lost in consequence of such visits, the directors had decided not to comply with any more applications of the same kind; but, of course, he was at liberty to go and look at the works from the outside. (Laughter.) He moved that a small committee of shareholders be formed to investigate as to the prospects of the company, and report to an adjourned meeting.

Mr. PRITCHARD seconded. From time to time he had, perhaps

foolishly, increased his holding in the company, having thorough confidence that all the statements had been correct. Certainly it appeared to him that the scientific and mechanical processes could not be separated, but they were told that the scientific process had been a success, but that difficulties had arisen in connection with the mechanical process. He thought the glowing reports which had been issued had been very prejudicial to the company, and that it would be best for them to go quietly on, without making a great show.

Mr. W. G. JOHNSON said he did not consider that his colleague, Mr. Hooley, and he, the two new directors, came into office until next Monday, and therefore they were not responsible for the promises made, and they would not make any promises. All they would do was to try and work the concern on business principles, and hope for some valuable results. As to why there had been no profits, they had a magnificent dividend declared. If he had been connected with the board at that time, that dividend would not have been declared. He would have wanted the money for working capital; for they had no plant, and the money should have gone in fitting up their works with a stock of machinery and plant capable of turning out the work. He believed the principle of the patent was a good one, but it had not been worked, and had not yet had a chance. He considered the works had not yet been properly started.

Mr. HAYS appealed to Mr. Squire to withdraw his amendment. They had had a committee in the gentlemen who had addressed them, and who had gone carefully into the matter, formed their opinion, and backed their opinion by putting a lot of money into the concern. Unfortunately, there had been one element in London which he had always been opposed to, and had viewed with a great deal of disfavour. It had always been, "Look at the price of our shares." All they had got to do was to make their goods, and make a profit, and they would see where their shares would be.

Mr. HOOLEY said he had joined the board on condition that certain directors retired, because he thought that the thing had been mismanaged. Another condition he laid down was that there should be no directors' fees paid until something was earned. Mr. Johnson and he had inspected the works, and they found that there was not plant sufficient to turn the work out; the works were incomplete, and they wanted to put in a proper plant to do the work.

Mr. JOHNSON said he objected to the committee. The time would be taken up with letters and telegrams; and they wanted to get into solid business.

Mr. HOOLEY said they wanted to put something into the day-book; that was the plain English of it.

Mr. SQUIRE said, after the appeal made to him by the solicitor, he would be pleased to withdraw the motion for a committee. But he would make one little condition, that the board would allow him to make some investigations for himself.

The CHAIRMAN said they would be very pleased for him to.

Mr. SQUIRE asked if the Nottingham contract had fallen through?

Mr. HAYS said it would be better not to press that matter, but it had not fallen through.

A SHAREHOLDER criticised the item of £60,938 13s. 8d., which appeared on the balance-sheet for land. He feared the purchase was a grievous mistake.

The CHAIRMAN said it was quite the contrary.

Mr. JOHNSON said he considered they had a splendid asset in that land.

The CHAIRMAN said he was responsible for bringing the works to Leeds. He found that a place was being negotiated for at Sheffield, which was not suitable, and he said if that was taken he should resign. The land in Leeds was therefore secured; it was near the railway, and the value had increased.

The SHAREHOLDER remarked that the land was under water during the recent floods.

Mr. S. ELMORE pointed out that that was the biggest flood for 30 years.

Mr. HOOLEY said there was now a new board, who in any case were not responsible for the purchase which was effected by the old board.

The seconder of Mr. Squire's amendment having concurred in its withdrawal, the chairman's motion was then agreed to unanimously.

The CHAIRMAN moved the re-election of Mr. J. T. Cooper and Mr. William Elmore as directors.

Mr. J. SHURMER seconded.

The motion was unanimously agreed to.

Mr. RAWSON moved the re-election of Messrs. Price, Waterhouse and Co., as auditors.

Mr. JOHNSON seconded this, which was also unanimously carried.

This concluded the business of the meeting.

Elmore's Wire Manufacturing Company, Limited.

FOLLOWING the meeting of Elmore's Copper Depositing Company, the second annual meeting of Elmore's Wire Manufacturing Company, Limited, was held. Mr. J. Jepson Atkinson again presided, and there was a considerably diminished attendance, some of those present at the previous meeting having gone to visit the works. The proceedings were very brief.

The CHAIRMAN said he did not propose to make a speech, as he thought that would be unnecessary after the other meeting which had just been held. He therefore moved formally that the report and accounts be received and adopted.

Mr. HAYS seconded.

The CHAIRMAN was about to put the motion, when

Mr. E. P. MACSTEAD asked if there was to be no discussion on the accounts?

It was suggested that the Secretary should read them.

Mr. HAYS said that would take half an hour.

In reply to Mr. MACSTEAD,

Mr. JOHNSON said they considered the wire works would be begun in earnest next week.

Mr. MACSTEAD said he thought it was 18 months' ago that they were told that there was enough work to keep the works going for 18 months.

Mr. HAYS said some clients of his would have given them an order for an immense quantity, but they could not deliver it.

Mr. HOOLEY said they only wanted money for plant.

Mr. MACSTEAD said this was the first he had heard about the want of money. They could hardly want money, as they had plenty of copper.

The CHAIRMAN said the money would all be found. The old directors expected a return of 25 per cent., and he believed it still.

Mr. HOOLEY said they were able to sell any amount of wire, but the profit was small; it was not like the copper. It was a case of selling a penny loaf for a penny.

The Chairman's motion was then agreed to unanimously.

Mr. HOOLEY moved, and Mr. HAYS seconded, the re-election of Mr. Cooper and Mr. Atkinson as directors, and this was carried unanimously.

The auditors, Messrs. Deloitte, Dever, Griffiths & Co., of 4, Lothbury, were also re-elected, and the meeting ended with a vote of thanks to the directors, proposed by Mr. Hays.

Chatham and Rochester Electric Lighting Company.

THE directors of the Chatham, Rochester, &c., Electric Lighting Company, in their annual report, announce the completion of the building of the new central station. Two artesian wells have been sunk, which will give a supply from 20,000 to 30,000 gallons of water per hour. A large and powerful Roby engine has been erected, which is supplied with steam from two Babcock-Wilcox boilers, which machinery is driving a new 2,400 volt Ferranti dynamo. Another boiler is also being erected, and contracts entered into for the supply of two 100-H.P. engines by Marshall & Sons, and two 2,400-volt dynamos of the Mordey type, and when these are erected, the installation will be fully and completely duplicated, and capable of maintaining an output of 7,000 8-candle-power. A contract has also been entered into for the supplying and laying down underground mains on the Brooks patent system of oil insulation, Chatham being the first large town in which this system has been adopted, in consequence of which the company has been enabled to make specially advantageous terms, by which a three years' guarantee of satisfactory working has been secured. The company is now being worked at an annual expense of £1,000, with an income of £1,400, and with the new plant laid down, the company will have an earning capacity of more than £6,000 per annum, while the working expenses will not be more than £2,000.

The Helios Electrical Company.—The report for the year 1891-1892 of the Helios Actien Gesellschaft Fur Electrisches Licht und Telegraphenbau of Cologne-Ehrenfeld refers to the central stations carried out by the company in Cologne and Amsterdam. The company had participated in the formation of the Gesellschaft Elektra in Amsterdam to the extent of 354,000 florins in shares and 350,000 florins in bonds. The consumption of current in the latter town always being on the increase, the Helios Company expect to share in the profits of that concern. An agreement had been entered into with an American company for the manufacture of the Helios arc lamps, whilst the company had obtained from Mr. Nikola Teala a license for Germany for the sole right to use his Drehström patents for the production of motors and the carrying out of works on that system. This combined with the other patents held by the company, would, the report states, prevent any one else from executing undertakings according to that method. The net receipts for the year were £3,227.

Electricity Supply Corporation, Limited. — The Electricity Supply Corporation, Limited, notify us that the 5 per cent. interest, payable to debenture holders on January 1st next, will be payable at the Union Bank of London on presentation of the coupons.

Stock Exchange Announcements.—Applications have been made to the Stock Exchange Committee to allow the following securities to be quoted in the Official List:—Notting Hill Electric Lighting Company, Limited—vendors' shares, Nos. 8 to 141.

TRAFFIC RECEIPTS.

The City and South London Railway Company. The receipts for the week ending January 1st 1893, amounted to £966; corresponding month, 1892, £878; increase £88; total receipts for half-year, 1892, £22,550; corresponding period, 1891, £20,335; increase £2,215.

The Direct Spanish Telegraph Company, Limited. The estimated receipts for the month of December, 1892, amounted to £2,092, against £2,180 in the corresponding period of last year.

The Great Northern Telegraph Company. The traffic receipts in December, 1892, amounted to £30,800. 1st January—31st December, 1892, £366,400, corresponding months, 1891, £382,600; corresponding months, 1890, £380,000.

The Western and Brazilian Telegraph Company, Limited. The receipts for the week ending December 30th, after deducting 17 per cent. of the gross receipts payable to the London Platino-Brazilian Telegraph Company, Limited, were £3,252.

SHARE LIST OF ELECTRICAL COMPANIES.

Present Issue.	Name.	Stock or Share.	Closing Quotation, December 29th.	Closing Quotation January 5th.	Business done during the year ended December 31st, 1892. Highest.	Lowest.
195,100*l*	African Direct Telegraph, Ltd., 4 p. c., Deb. Regd. and to Bearer	100	100 — 103	99 —102 xd	103	100½
1,247,720*l*	Anglo-American Telegraph, Limited	Stock	50 — 51	51½— 52½	51⅞	46½
2,876,140*l*	Do. do. 6 p. c. Preferred	Stock	91½— 92½	93 — 94	92½	87½
2,876,140*l*	Do. do. Deferred	Stock	10½— 11	11 — 11½	15½	9⅞
130,000	Brazilian Submarine Telegraph, Limited	10	10⅞— 11¼	11 — 11½	11⅝	10¼
34,600*l*	Do. do. 5 p. c. Bonds	100	101 —104	101 —104	103⅝	101
75,000*l*	Do. do. 5 p. c., 2nd Series, repayable in June, 1906 ...	100	106 —110	104 —108 xd	110	104⅜
77,978	Brush Electrical Engineering Ordinary, Nos. 1 to 63,416	3	3 — 3¼	3 — 3¼	3 7/16	2⅞
75,000	Do. do. Non cum. 6 p. c. Preference, Nos. 1 to 63,416	2	2¼— 2½	2¼— 2½	3	2
125,000*l*	Do. do. 4½ per cent. Debenture Stock	Stock	... ...	100 —102	...	...
40,000	Chili Telephone, Limited, Nos. 1 to 40,000	5	3 — 4	3 — 4	3⅜	3¼
600,000*l*	City and South London Railway	Stock	35 — 38	35 — 38	37½	...
50,000*l*	Do. do. do. Nos. 1 to 50,000	10	... ...	... ...	3⅜	2⅜
40,000	City of London Elec. Lighting Co., Ltd., Ord. 40,001-80,000 ...	10	10¼— 10⅜	10½— 11	11¼	5⅜
20,000	Do. do. 6 p. c. Cum. Pref., Nos. 1 to 20,000	10	5 — 5⅛	5½— 5½	5½	5⅛
$7,716,000	Commercial Cable, Capital Stock	$100	175 — 180	175 —180	182½	151
224,850	Consolidated Telephone Construction and Maintenance, Limited ..	14/-	3/16— 5/16	3/16— 5/16	½	¼
20,000	Crompton & Co., Ltd, 7 p. c. Cum. Pref. Shares, Nos. 1 to 20,000	5	5 — 5¼	5 — 5¼ xd	6⅜	5
16,000	Cuba Telegraph, Limited	10	11½— 12½	11½— 12½	12¼	10¼
6,000	Do. do. 10 p. c. Preference	10	17½— 18½	17½— 18½	18¼	16½
12,931	Direct Spanish Telegraph, Limited, ... (£4 only paid)	5	2½— 3½	2 — 3	3⅝	3¼
6,000	Do. do. 10 p. c. Preference	5	9 — 10	9 — 10	11	9
60,710	Direct United States Cable, Limited, 1877	20	11½ — 11⅝	11½— 11½	12 1/16	10⅞
400,000	Eastern Telegraph, Limited, Nos. 1 to 400,000	10	14⅝— 14¾	14⅝— 15	15⅝	14
70,000	Do. 6 p. c. Preference	10	16 — 16½	16 — 16½	16¼	14 11/16
200,000*l*	Do. 5 p. c. Debs. (1879 issue), repay. August, 1899	100	107 —110	107 —110	110	106
1,200,000*l*	Do. 4 p. c. Mortgage Debenture Stock	Stock	109 —112	109 —112	114⅜	107
250,000	Eastern Extension, Australasia and China Telegraph, Limited ...	10	14⅜— 15	14⅜— 15	16½	14⅜
70,600*l*	{ Do. 5 p. c. (Aus. Gov. Sub.), Deb., 1900, red. ann. drgs. reg. 1 to 1,049, 3,976 to 4,326 }	100	104 —107	102 —105 xd	104⅜	103
250,200*l*	Do. do. Bearer Nos. 1050—3,975 and 4,327—6,400 ...	100	104 —107	102 —105 xd	106½	102¼
320,000*l*	Do. 4 p. c. Debenture Stock	Stock	109 —112	110 —113	111½	106¼
122,400*l*	{ Eastern and South African Telegraph, Ltd., 5 p. c. Mort. Deb. 1900 redeem. ann. drawings, Registered Nos. 1 to 2,343 }	100	103 —106	101 —104 xd	106	101
163,700*l*	Do. do. do. to bearer, Nos. 2,344 to 5,500	...	104 —107	101 —104 xd	104½	101
300,000*l*	Do. do. 4 p. c. Mort. Debs. Nos. 1 to 2016, red. 1909	100	103 —106	103 —106	105⅜	100¼
45,000	Electric Construction, Limited, Nos. 101 to 45,100	10	2 — 2½	2¼— 2⅜	6½	1⅜
19,900	*Electricity Supply Co. of Spain, Nos. 101 to 20,000	5	... ...	... ...	...	...
100,000	Elmore's French Patent Copper Depositing Co., Ltd, Nos. 1 to 66,750	2	3/16— 5/16	1/16— 1/8	4	3/16
82,395	Elmore's Patent Copper Depositing, Limited., Nos. 1 to 70,000 ...	2	5/16— 7/16	5/16— 7/16	4 5/16	1 1/16
67,385	Elmore's Wire Mfg., Ltd., Nos. 1 to 67,385, issued at 1 p.m., all pd,	2	½— ¾	½— ¾	2 1/16	9/16
20,000	Fowler-Waring Cables, Nos. 301 to 20,300 ... (£4 10s. only paid)	5	2 — 3	2 — 3	3 1/16	2
180,227	Globe Telegraph and Trust, Limited	10	9⅜— 10	9⅜— 10	10⅜	9⅜
180,042	Do. do. 6 p. c. Preference	10	14⅞— 15⅛	15 — 15¼	15⅜	14¼
150,000	Great Northern Tel. Company of Copenhagen	10	19½— 19⅝	19 —19½ xd	20	18½
210,000*l*	Do. do. 5 p. c. Debs. (issue of 1883) ...	100	104 —107	104 —107	108⅜	103½
12,134*l*	Greenwood and Batley, Ltd., Ordinary, Nos. 4667 to 14,000 ...	10	4½— 5½	4½— 5½	...	...
9,600*l*	Do. 7 p. c. Cumulative Preference, Nos. 2,667 to 8,000	10	8 — 9	8 — 9	...	...
50,000	India-Rubber, Gutta Percha and Telegraph Works, Limited ..	10	21½ — 22½	21½ — 22½	23	19½
200,000*l*	Do. do. 4½ p. c., Deb., 1896	100	102 —104	102 —104	105	103⅜
17,000	Indo-European Telegraph, Limited	25	44 — 46	44 — 46	45⅜	39½
11,334	International Okonite, Ltd., Ordinary Nos. 22,667 to 34,000	10	2½— 3½	2½— 3½	5	3¼
11,334	Do. do. Preference Nos. 5,667 to 17,000 ...	10	6 — 7	6 — 7	...	...
30,000	†Liverpool Electric Supply, £3 10s. paid	5	3 7/16— 3 9/16	3⅜— 3⅜	3½	2⅝
10,000	Do. do. fully paid	5	5 3/16— 5 5/16	5 1/16— 5 7/16	5¼	4⅞
38,348	London Platino-Brasilian Telegraph, Limited	10	4 — 6	4 — 6	...	...
100,000*l*	Do. do. do. 6 p. c. Debentures	100	108 —111	108 —111	109	107½
49,900	*Metropolitan Electric Supply, Ltd., Nos. 6,101 to 50,000 (£9 paid)	10	6¼— 7	6⅜— 7¼	10	6½
50,000*l*	Do. 5 p.c. debentures, 1 to 5,000 in bonds of £10, £20, £40	...	102 —105	102 —105	106	103
454,747	National Telephone, Limited, Nos. 1. to 438,984	5	4⅜— 5	4⅜— 5	5 3/16	4 1/16
15,000	Do. 6 p. c. Cum., 1st Preference	10	14 — 15	14 — 15	14 13/16	12⅝
15,000	Do. 6. p. c. Cum. 2nd Preference	10	13⅜— 14½	13⅜— 14½	14 1/16	12
90,950	Do. 5 p. c. Non-cum. 3rd Pref., Nos. 1 to 90,950 ...	5	4½— 4⅝	4½— 4⅝	4 1/16	3 5/16
726,477*l*	Do. 4½ p.c. Deb. Stock Prov. Certs. fully paid ...	...	112 —114	111 —113 xd	114	105
48,800*l*	New Telephone, Limited, Nos. 25,901 to 74,700 ... (£2 paid)	10	4⅜— 5	4⅜— 5	4 7/8	1
6,318	Notting Hill Electric Lighting Company, Limited, fully paid ...	10	5 — 6	5 — 6	6	3⅞
220,000	Oriental Telephone, Ltd., Nos. 80,001 to 300,000 (11s. only paid)	1	3/16— 5/16	3/16— 5/16	¼	...
11,802	Reuter's Limited	8	7½— 8½	7½— 8½	8⅜	5½
18,680	St. James's & Pall Mall Electric Light Co., Ltd., Ord., 101—18,780	5	7⅞— 8¼	7⅞— 8¼	9	7⅛
20,000	Do. do. 7 per cent. pref., Nos. 20,081 to 40,080	5	8¼— 8⅜	8¼— 8⅜	8 7/16	7
3,381	Submarine Cables Trust	Cert.	116 —120	117 —122	120	115½
78,949	Swan United Electric Light, Limited ... ... (£3½ only paid)	5	3 — 3½	3 — 3½	4 1/16	2½
37,350	Telegraph Construction and Maintenance, Limited	12	45 — 47	45 — 47	47	42½
150,000*l*	Do do. do. 5 p. c. Bonds, red. 1894	100	103 —106	101 —104 xd	105⅜	102
58,000	United River Plate Telephone, Limited	5	2⅜— 3¼	2⅜— 3¼	2 1/16	1 1/16
146,370*l*	Do. do. 5 p. c. Debenture Stock ...	Stock	90 — 100	90 —100 xd	90	...
15,609	West African Telegraph, Limited, Nos. 7,501 to 23,109	10	6½— 7½	6½— 7½	7¼	...
260,900*l*	Do. do. do. 5 p. c. Debentures	100	100 —103	100 —103	104	99
30,000	West Coast of America Telegraph, Limited	10	2½— 3½	2½— 3½	4⅞	2⅜
150,000*l*	Do. do. do. 8 p. c. Debs., repayable 1902 ...	100	104 —108	100 —104 xd	105	100
64,242	Western and Brazilian Telegraph, Limited	15	7 — 7½	7¼— 7⅜	10⅜	7⅛
33,129	Do. do. do. 5 p. c. Cum. Preferred	7½	5½— 5⅝	5½— 6	6⅜	5⅛
33,129	Do. do. do. 5 p. c. Deferred	7½	1½— 2	1⅜— 2⅛	4 5/16	1⅛
184,100*l*	Do. do. do. 6 p. c. Debentures "A," 1910 ...	100	106 —109	106 —109	107¼	103
230,100*l*	Do. 6 p. c. Mort. Debs., series "B" of '80, red. Feb., 1910	100	106 —109	106 —109	109	103½
88,321	West India and Panama Telegraph, Limited	10	1⅛— 1⅜	1⅛— 1⅛	1⅞	1⅛
34,563	Do. do. do. 6 p. c. 1st Preference ...	10	10 — 10½	10⅛— 10⅜	10 13/16	9½
4,669	Do. do do. 6 p. c. 2nd Preference ...	10	8 — 9	8½— 9½	9½	8
80,000*l*	Do. do. 5 per cent debentures (1917) No. 1 to 1,000	100	105 —108	103 —106 xd	105½	101½
$1,536,000	Western Union of U.S. Tel., 7 p. c. 1st Mortgage (Building) Bonds	$1,000	120 —125	120 —125	123½	120½
171,000*l*	Do. do. 6 p. c. Sterling Bonds	100	100 —103	100 —103	100½	...
59,900	*Westminster Electric Supply Corp., Ord., Nos. 101 to 42,953 ...	5	5½— 6	5½— 6	7 1/16	5

* Subject to Founders' Shares. † Quotations on Liverpool Stock Exchange.

LATEST PROCURABLE QUOTATIONS OF SECURITIES NOT OFFICIALLY QUOTED:—Blackpool Electric Tramway Company, Limited, £10 (£6½ paid), 7½—7⅝.—Brush Company 4½ per cent. Debenture stock, issued at 1 per cent. premium, 100—103.—Electric and General Investment, shares of £5 (£1 paid), 1⅜—2¼xd.—Founders' shares, 200—225.—Electric Construction Corporation, 6 per cent. Debentures, 95—98.—Electricity Supply Corporation, Ordinary of £5, 5—5½.—Elmore Foreign and Colonial Copper, Founders shares, 6¼—7½.—European Sims-Edison Torpedo Company, shares £20 (fully paid), 20—20½.—Founders' shares, 10—20.—Halifax and Bermuda Cable 4½ per cent. bonds 80—90.—House to House Company (£5 paid) 1½—2½.—Do. 7 per cent. Preference of £5, 5½—5⅝.—Do. 6 per cent. Debentures of £100, 97—102.—Kensington and Knightsbridge Electric Lighting Company, Limited, Ordinary Shares £5 (fully paid), 5—5½, 1st Preference Cumulative 6 per cent., £5 (fully paid), 6—6¼.—Liverpool Electric Supply Shares of £5 (fully paid), 5 1/16—5 3/16.—Manchester, Edison and Swan Company, £9 (£1 paid). ⅛—¼.—Queen Anne's Mansions Lighting and Heating, Deferred shares of £10 (fully paid), 10—½.—Do. 4½ per cent. Preference shares of £10 (fully paid), 10—¼.—Do. Debentures, 101—103.—Woodhouse & Rawson Ordinary of £5 (£2 10s. paid), ¼—½.—£5 Preference (fully paid), ⅝—¾.

The bank rate of discount during the year has changed as follows:—December 10th, 1891, 3½ per cent.; altered on January 21st, 1892, to 3 per cent.; April 7th 1892, to 2½ per cent., April 28th, 1892, to 2 per cent.; October 20th, 1892, to 3 per cent.

PROCEEDINGS OF SOCIETIES.

The Institution of Electrical Engineers.

AN ordinary general meeting of this institution was held on Thursday, December 1st, Prof. W. E. AYRTON, F.R.S., President, in the chair.

The minutes of the last ordinary general meeting having been read and approved, and other general business transacted, the discussion on Prof. Fleming's paper on "Experimental Researches on Alternate Current Transformers" was commenced.

Mr. J. SWINBURNE: As regards the electrostatic voltmeter, we had considered the question of putting oil and glycerine damping arrangements on these voltmeters, and came to the conclusion that they were rather unsatisfactory, and not very practical, and so we preferred the electro-magnetic method, and the damping arrangement works all right. Next, with regard to the voltmeter, Dr. Fleming's arrangement of putting mica to prevent sparking is good in some ways, but it might give trouble through small charges settling on the outside of the dielectric. In the 3-voltmeter method of measuring watts, of course the great difficulty is supposed to be the non-inductive resistance, and that is a hopeless thing to get over. I certainly think that a properly wound non-inductive resistance is more reliable, more trustworthy, than incandescent lamps. We do know what a resistance will do, and you can always make a resistance, so that you can calculate what the capacity and self-induction would be generally. It is quite ridiculously small. But when working with incandescent lamps, you are not sure in the least. There is considerable uncertainty as well as to what exactly an incandescent lamp does on alternating currents. For instance, at a certain pressure, there is a slight discharge across from terminal to terminal, inside the lamp, and a lot of small things like that which may cause errors, so I think a fine wire circuit infinitely better than an incandescent lamp. Coming now to a more important part of Dr. Fleming's paper. The first thing, I think, he shows is, that the wattmeter, providing, of course, you don't put a metallic case on the outside, is really an accurate method of testing power. That sweeps away at once the whole of the complications and difficulties in testing power. Anyone can make a wattmeter in which the self-induction or time constant of the fine wire circuit is practically nil. The next point that he settles definitely, I think, is that you can with practically all transformers get the efficiency at full load and at various loads. If you know the resistance of the circuits and the loss at no load, that is to say, the loss in iron remains practically constant throughout the load. Of course, it must fall a little at full load because the induction falls a little and the back E.M.F. falls a little. The third point which Dr. Fleming did not settle is that question of the open circuit *versus* the closed circuit transformer. What he has settled, I think I may say is, that our transformers were perfectly accurate. I think it has tested everything in every possible way, and I think the transformer is perfectly accurate; and I think that only shows that that transformer is not what I have held the Hedgehog transformer ought to be in the least, and it is as bad as most closed circuit transformers. I admit most of the transformers made recently are like that; how many of the old ones are I do not know, but we tested our iron carefully at first, and it seemed all right. I will give you a reason presently why it was wrong. We tested the iron first, it was no fault of the iron. We tested that wattmeter with no metallic case and therefore it was perfectly accurate and encouraged us to think it was quite right. It is only quite recently that we have hit upon what, I believe, is the real cause of the abnormal results in the Hedgehog and that is this, we know the core is composed of small iron wires, the small iron wires so well insulated that if you twist two of them together and test the resistance, it is something in ohms. But it had not occurred to us that when you put many tons pressure on these things, you make perfect contact without anything else, and that is the whole of the difficulty we have had in those tranformers we sent to Dr. Fleming. It was simply Foucault currents in the core. We know now what is wrong, and we are very much indebted to Dr. Fleming for showing us what is wrong. We shall have no difficulty at all in correcting that. A great many transformers which have really closed iron circuits, might have power factors upon which you might depend, but in the case of the Thomson-Houston, or those made by Brown and Bouverie, there is a joint made in the circuit, and very small variations of that joint will cause very large variations in the power factor, the result is that it would be very unfair to transformers like the Brown and Bouverie to take the power factor, as one might make a good joint and another a bad one. It would be injudicious. I would also point out that Dr. Fleming's method of determining the drop in transformers seems to me wrong. This summer I wrote a paper in *Industries* in which I gave a method which I believe to be the true method of predetermining the drop of transformers when your drawings are given, and it agrees very accurately with the results. It involves no complicated methods, and it seems to me right, but if it is right Dr. Fleming is entirely wrong. I do not think he takes it from the drawings, to begin with. He does not seem to appreciate that the back E.M.F., which causes the drop in the transformer, is a quarter of a period out of step with the real E.M.F., so you have to take the square root instead of two squares in that way. The effect of that can be very easily seen. If you take a transformer which is 1 per cent. and put on an electro-magnetic induction you drop 15 per cent.; that is because you have to subtract one from the other, instead of squaring them and taking the square root. It is a very important matter, and it is a matter which would be very much felt if voltmeters ever come in. But if voltmeters ever come in you will find very curious results with transformers having a transforming ratio as expected —sometimes transforming 10 per cent. high, and at others 10 per cent. low.

Prof. GEORGE FORBES: I would draw your attention to a case where the efficiency at low loads is not of so very much importance, and that is in the utilisation of water power for transmission to distances; especially when we are using transformers of considerable size, this becomes an important matter. The difference in design of a transformer to give you a very high efficiency at full load, or a good efficiency at nearly every load, consists in the relative proportions of copper and iron. If we wish to get excellent results at low load, we must put in a larger proportion of copper, whereas if we are content to have a high efficiency at the very large loads, then we can put in a much smaller quantity of copper and a certain larger quantity of iron. That is of course a cause of enormous reduction in the cost of transforming. Now, in the case of a transmission of power, the cost of the transmission is very great indeed. Consider the cost of a transmission of power from Niagara Falls to Buffalo where we are using units of 5,000 H.P. There, if we were to use alternating currents, we should be using a step-up transformer at Niagara Falls and a step-down transformer at Buffalo. The cost of each one of these transformers, according to the estimates put in up to the present time, is considerably in excess of the 5,000 H.P., dynamo which produces the current, and consequently the two transformers are nearly three times the cost of the dynamo which is generating the current. Now, of course this is a very serious item in the cost of the H.P. per annum at which it can be delivered at Buffalo, and it requires very little consideration to see that the value of our power, when a small amount of power is being used, is much less; that is to say, at low loads we can do perfectly well with a far lower efficiency than we can at high loads. In the case of the utilisation of water power, we want the highest efficiency we can get, when all the power is being delivered at Buffalo, and we do not care much about the efficiency of transformers at low loads; consequently we are able to produce transformers at an enormously reduced cost; I think it will come out something between half and one-third of the cost of transforming if they were made in the way they have been made for lighting purposes; that is to say, to get as good an efficiency as we can over the whole range.

Mr. GISBERT KAPP: Dr. Fleming has been at great trouble to investigate the accuracy of the 3-voltmeter method, and prefers the wattmeter. I know at Frankfort all measurements were made by wattmeter, and these instruments have been standardised in various ways, and the measurements were as accurate as possible. But, at the same time, I should like to put in a word for the voltmeter method, the accuracy of which Dr. Fleming seems to doubt. I have made a great many experiments with the 3-voltmeter method, using the same instrument for the three readings, by switching over into the mercury cups, and I found at first that the method seemed to be very inaccurate, but that was simply due to errors of reading. Now I take about 12 readings, in order to determine three quantities, that is to say, I read every quantity four times, and in this way I get readings which are perfectly consistent with each other. I may repeat the tests time after time, and I get exactly the same results, as near the same result as one may expect by readings of a multicellular voltmeter, where the readings are $\frac{1}{10}$th of an inch apart, so that the voltmeter method is perfectly accurate. I found it so, provided you take enough time over it. Change the connections, and read one quantity; change the connections and read the other, and so on; keep reading one after the other, and after taking each set of readings, you will find they are so close as to give you very consistent results. I might also mention that since the paper was read, and Dr. Fleming pointed out this possible explanation of the large Foucault loss in the Hedgehog, I have made a test on a transformer bound with very stout secondary copper, 512 mils. per 120, and then exactly the same core wound with a thin wire, and curiously enough the transformer which had the stout core—I am speaking from memory—gave about 120 watts total loss, including hystereses, and that with no copper at all it gave 130, so I do not believe it is in the copper. We find, by Dr. Fleming's tables, it is quite possible to have transformers with 75 per cent. at one-twentieth of their full load, and as much as 85 per cent. at one-tenth of their full load. Now a transformer will never sink below one-twentieth; it is generally in the neighbourhood of one-tenth, and consequently this lowest point will be raised as time goes on, because the more houses joined, and the more different classes of house put on the mains, the more do the different requirements overlap, so that the tendency is to raise the lowest part of the load curve, and now we find, taking an average, that a transformer, even in the hours of lightest load, will give us 80 per cent. efficiency—that is to say, when we are earning least, we are wasting 20 per cent., and when we are earning most, that is in the hours of heavy load, between 6 and half-past 8, we are getting an efficiency of 96 per cent., wasting only 4 per cent., so that, taking the whole efficiency of the system for over 24 hours, we get now, with transformers, actually a higher efficiency than with a continuous current, if the feeders consume 20 per cent. heavily loaded, for continuous transformers the greatest loss is on the light load. (In answer to the President): The transformer I experimented with was a closed circuit one, the thick copper was next the iron, the thin copper was outside this, and was not used in the test at all. The power was supplied at 100 volts to the thick copper in one case, and then a precisely similar carcase was taken again of closed magnetic circuit, and wound with very thin copper—I think it was 120 mils. diameter, exactly the same number of turns, and exactly the same relative position as the thick copper in the real transformer, but the copper is not wound quite close to the iron. It is a transformer very much of the same kind as those made by Brown and Bouverie, to which Mr. Swinburne has referred. The copper is wound on a separate sleeve, and slipped over the core.

Mr. SIDNEY EVERSHED: I cannot help thinking that that estimate of difference between open and closed circuit transformers, only 2 or 3 per cent., is more likely to be near the truth than those estimates which Mr. Swinburne gives from time to time, and at the close of

those articles I drew attention to the fact that the difference was small between open and closed circuit transformers designed on good lines. Mr. Vignolles and I carried out an experiment which proved quite conclusively that there was no falling off in the loss as you loaded up a transformer.

Mr. MORDEY then read a short paper communicated by Mr. W. B. SAYER.

Sir DAVID SALOMONS then described his high frequency alternator. In the apparatus there are two discs, each disc having an outer ring. Let us consider one disc for a moment. The outer ring has a number of teeth cut in it pointing toward one another; they are cut at the rate of a little over of 10 to the inch. Each one is wound zigzag, with wires something like the old Ferranti armatures. Not quite, but nearly so. On each one is one set of teeth forming the inductor poles, and the others the poles of the armature. Clearly, as these pass each other, one being magnetised, you produce in the other an alternating current, the frequency being determined by the speed. There is a difficulty in getting up sufficient speed without having a very large diameter. To get over that difficulty they are made to rotate in opposite directions. Therefore for a given rate you have double the rate of the polar projections passing one another. Multiplying the revolutions by 360, and you have over a million a minute; theoretically, there is no reason that this should not be so, and it can be tested by a revolving mirror or some other method.

AN ordinary general meeting of the institution was held on Thursday, December the 8th, 1892, Prof. W. E. Aryton, F.R.S., president in the chair.

The minutes of the last general meeting having been read and approved,

The PRESIDENT alluded in suitable terms to the death of Dr. Werner von Siemens, and proposed a resolution of condolence with his family "That the president, council, and members of this institution desire to record hereby their profound regret at the decease of their distinguished foreign member and local honorary secretary and treasurer in Germany, Dr. Werner von Siemens, and that they further desire to express their sincere sympathy with his widow and the other members of his family in their great bereavement." The resolution was seconded by Prof. GEORGE FORBES, F.R.S., and carried unanimously.

The secretary having read the annual report of the Council, the president moved, and Mr. A. STROH seconded its adoption. The motion was carried unanimously.

Mr. A. P. TROTTER: Sir, I have given notice of a question to the Secretary. I wish to make very few observations upon the subject and it is merely this; the present process of balloting for associates has been in vogue for some time. I wish to say nothing about the election of Students (that should be encouraged), nor of full Members. That is chiefly in the hands of the Council (Sir DAVID SALOMONS, No, no). Possibly not; but I understand that the Council pays special attention to the qualification of Members. But I refer only to the election of Associates. As we come into this room we receive balloting papers, and it appears from many members—it may be quite wrong; I merely ask the question—that it is almost impossible for anyone to effectually oppose the election of an associate. Take for example this case; supposing so many names are down on each balloting paper. A large number of members, I believe, without any personal knowledge of those associates, put their papers into the box. Supposing certain members desire to black ball one person, they are practically outweighed by five to one. I therefore wish to ask, just to test whether this is the case or whether I and others are in error, how many candidates have presented themselves for election as associates since the present mode of balloting was adopted and how many of those have been actually elected.

The SECRETARY: Since the present method has been in vogue 163 candidates have been nominated for election as associates and 163 have been elected.

Major-General WEBBER: Mr. President and Gentlemen,—There is nothing which we, as an institution, ought to defend more, and be more particular about, than the system of election. It is quite true what Mr. Trotter has said. In the case of membership, either for removal from the position of associate to that of member or the election of new members, the council passes the qualification of the candidates under the strict supervision, and particularly with reference to our published rules of qualifications. But, as regards the class of associates, there is a certain latitude, and the numbers are so large that the council cannot—it is out of their power to do so—verify and scrutinise as much as perhaps they might be expected to do by the general body of the Institution. I, for one, extremely regret that the system of election formerly in vogue, that is to say, by ballot box, has been done away with. I feel pretty sure that the expression of opinion and feeling of which Mr. Trotter has been the mouth-piece, is one that is felt, to a certain extent, by our members as a general body of members, and that he has only given expression to that feeling because he was aware that it was one that ought to be put forward, and ought to be investigated by the council. I think, myself, if Mr. Trotter were to move the council, or any number of members, supporting his wish, that the system by ballot box should be brought into existence again, it would receive the most serious consideration of that body.

Sir DAVID SALOMONS: I do not wish to waste your time, but I think I can answer the question in a moment. Major-General Webber is a very old member, but for many years past I do not think I have missed more than one or two meetings. Every nomination of an associate requires the names of a proposer and seconder, and if these are proper names we accept their word as to the qualification of the candidate, unless any special question arises. I think this is satisfactory. As regards the ballot boxes, I think I had better explain, as my friend General Webber is in favour of the ballot box. I think it is a matter of congratulation to us, as those boxes have disappeared simply because there are so many joining our ranks that it is not possible to use the ballot boxes; the number is so large that it is impossible to work with them, as you would see at the next meeting if we were to use them.

The SECRETARY: The President allows me to say a word in connection with this matter. I do not know whether it has escaped General Webber's memory, or whether he was away at the time the change was made. The change was made because it was found impracticable without using the same ballot boxes two or three times. For the same reason the civil engineers abolished the ballot boxes and took to the nomination paper. We have followed their footsteps as in other matters, simply because we found it to be practically impossible to go on in the old way. Sometimes we have had as many as 50 or 60 candidates, and it was very difficult to get members to remain while the change was being made. It was on that account that this change was made, and an explanation was given at the time.

A MEMBER: That hardly meets Mr. Trotter's very obvious suggestion.

Mr. G. L. ADDENBROOKE: I might add that if there is any difficulty about the election of associates—I believe two names are required, two backers for the election of an associate. I simply beg to move that a third name be added.

The SECRETARY: That the articles of association may be complied with, any change of that sort will require a special general meeting, and another confirmatory meeting. Our rules, which are really articles of association, are fully complied with. They require that a candidate shall be proposed by one member and seconded by another. As a general rule we have several additional names.

A MEMBER: I should like to ask how many black balls at present exclude?

The SECRETARY: Two-thirds white balls are necessary. I may mention, with reference to Mr. Trotter's question, that I think perhaps a wrong inference is brought, judging from the cheers with which my answer to his question was received, namely, that so many associates have been proposed, and the same number elected. But I may mention that during the long period I have had the honour of being your secretary, there has been, I believe, only one case, certainly not more than two, where a candidate has been black-balled, and such a case, on the requisition of more than five members, can be brought up again. In the case I have alluded to that was done, and the candidate was re-elected without any further difficulty. With that exception during the 14 or 15 years, even under the old system, there was no black balling. I do not think, therefore, that the new system is responsible for anything in that way.

Mr. KAPP: I quite appreciate Mr. Trotter's intention of having a more rigorous ballot. But from a practical point of view I do not believe that ballot boxes are any better than the papers, and I speak from my own experience. I am one of those individuals who are always pressed by the secretary to do certain work. I remember at the end of certain meeting when I wanted to get away to catch my train, the secretary has come to me and said "Now vote, here are the balls." And I would throw them in, and sometimes they went into the wrong compartment. I maintain that is a far worse system than when the secretary gives me a paper and I can strike a name out if I want to black ball. The hurried voting with the ballot box was certainly worse than the present system.

Mr. SWINBURNE: Does striking out one name black ball, or does it merely mean that he is not voted for? You cannot, as I understand it, black ball one man without black balling the whole list.

Mr. VIGNOLLES: May I make a small suggestion which may get over the difficulty. It appears to be agreed that the difficulty is the number of ballot boxes that would be necessary, and it is a very serious one. But you could combine the advantages of both systems by simply voting for or against a person on the present balloting papers. That is to say, you should make a certain mark if you wish to vote for, and strike out the name if you wish to vote against a man. That seems to me to combine the advantages of both systems.

Sir DAVID SALOMONS: Perhaps you would accept a proposition on the part of the council at the next meeting. There appears to be a difficulty and perhaps if we had something printed at the bottom of the ballot paper it would get over it.

A MEMBER: Would you have the proposer and seconder printed as well? That perhaps would satisfy some members.

The PRESIDENT: Are these definite propositions, or merely suggestions? Of course, there is no doubt that this Society labours under one very great disadvantage—it is extremely popular, and is becoming more and more popular, and the number of candidates coming in is so enormous that it is extremely difficult to do anything but what we do, but at the same time if any definite proposition is put before the meeting, the council, of course, would give it full consideration.

Mr. BIGGS: What on earth are the council for if they are not the proper persons to decide upon the qualifications of candidates? It is not a matter which should concern the general body of the members.

Mr. SWINBURNE: Is it not in the hands of the members generally now under the articles of association?

Mr. BIGGS: I do not think so. I understand that the council have authority to examine the qualifications of candidates, and they suggest that they should be elected.

Mr. ADDENBROOKE: I beg to propose that the whole question be referred back to the council for their consideration and report.

Mr. BOND: I beg to second that.

The PRESIDENT: I do not think there is anything to refer back. What do you propose to refer?

Mr. ADDENBROOKE: The election of associates. Owing to the growth of electrical engineering and the commercial value of the letters M.I.E.E., that the whole question be referred to the consideration of the council.

Mr. TROTTER: In asking this question, I distinctly declined to offer any suggestions, because I think it is a question which the council are fully able to deal with, and a matter which ought to be left to the council, in whom we ought to have confidence.

The matter then dropped.

The usual votes of thanks were then proposed, seconded, and carried.

The discussion on Dr. Fleming's paper, "Experimental Researches on Alternate Current Transformers," was then continued.

Mr. W. M. MORDEY: In some experiments I recently made I first used a 5 horse-power Ferranti transformer on the 2,400 volts mains from Trafalgar Square. On the same mains there were many transformers in use in customer's houses, and in parallel with this transformer was another only a few feet away, I mention that because if the effect occurred it could scarcely be a capacity effect, because when a number are connected in parallel forming a connection across the mains, it is impossible that there should be a capacity effect. Then a 100-volt lamp was put in series with the primary transformer, the secondary being open, and the primary circuit was closed rapidly. Out of 47 contacts there were seven bad rushes of current. These rushes were so brilliant that I was afraid the lamp would break exactly in the way in which Dr. Fleming has described. Besides these seven bad rushes of magnetising current when the transformer was switched on, out of 47 there were a number in which there was a minor rush—a considerable increase over the normal magnetising current. Then a secondary circuit of non-inductional resistance was put on with 11 ampères and 50 volts. The rushes were just as noticeable as before. Out of 46 contacts there were five bad rushes, and six or eight minor rushes. With the same arrangement, but with the primary closed all the time, the secondary was made and broken many times, and there was no abnormal increase of current in the primary. Then a 20 horse-power Ferranti transformer was put on, and tried in the same way. Sixty contacts were made; there were five or six small rushes of current, and then the last contact broke the lamp by an extremely violent rush. I think there must have been 20 ampères through that lamp instead of a fraction of an ampère. That entirely confirms, so far, what Dr. Fleming has said. Then I put one of my 20 horse-power transformers, made by the Brush Company for the London mains in the place of the Ferranti, with the lamp on the line side of the primary. I tried the earth on the other side of the primary, and with the secondary circuit open. Out of 56 contacts I only noticed one little flash, one very small increase. Then I put a 50 volt lamp in series with the primary. For more sensitiveness a 100 volt lamp was put on, and in 100 contacts there were two or three trifling rushes of current. It was scarcely perceptible, the effect was so slight. There were some other experiments, several hundred contacts were made with that transformer and they all came to the same thing. This shows that the effect may range from very slight to very objectionable, according to the design of the transformer used; that the presence of a load on a secondary, does not prevent it; that the presence of other transformers in parallel disposes of the supposition that it is a capacity effect on the mains. Out of the large number of transformers we have supplied to the City of London Company some were being put on and I took the occasion of breaking and making circuit there, but could get no such effect on the 24 horse-power transformer. This 24 horse-power transformer was tried in the shops in the same way and out of 485 contacts I could get no effect. The contacts were made by a switch. By pulling the contact down that way (indicating) I could get no such effect. Then I made a number of experiments with a large amount of rubber cable in the circuit to give a certain amount of capacity, and with the same alternating armatures on each side of the transformer, but I got no effect at all. Then I took a 5 horse-power Ferranti transformer, one I had used at the London Electric and made 400 contacts with that and got no effect at all at 100 ~, whereas at the London Electric station at 83 ~, the effect was very marked and frequent. Then I made 100 contacts at 1,800 volts with this Ferranti transformer and got about a dozen flashes at 83 periods; at 100 periods I could get nothing at all. Then I put my 24 horse-power transformer on at 83 periods and 1,800 volts and out of 126 contacts got four effects. At 100 periods and 2,000 volts a large number of contacts were made with no effect. To find the effect with a rapid action of the switch—I thought possibly the rapidity of closing the switch might have something to do with it, that at a low frequency one would be more likely to get on to a definite part of the curve instead of coming down on two or three waves—I reduced the frequency; and instead of 100 I tried 50 slow contacts, and I got no effect. Then I tried by making very quick contacts by tapping the wire and I got a very violent effect indeed at 50 periods, showing, in fact, that the contact made in that way was not an instantaneous contact at all, but that if you made a very quick contact you might get this effect. This was tried at 100 periods at slow contact and there was no effect; but with very rapid contacts there were occasional rushes, the lamp varying from black to fair incandescence, showing that it ran up to its normal magnetising current to half an ampère. These experiments show that there is a relation between frequency and time of switching; the lower the frequency the worse the result. Of course, when one gets on the right track, it is pretty easy to go on. Then it occurred to me that rapid breaking might be made with rapid making. I thought that slow break might, by going on, leave the transformer unmagnetised. I was still on the assumption that the transformer was left magnetised by the last wave. I thought, if I could draw out the curve so that the following waves gradually decreased until they were very small, that I should leave the residuum magnetism very slight indeed in the transformer. It appeared probable that rapid breaking would be harmless if it followed slow breaking, because, by slow breaking, the current would be tailed off in gradually decreasing waves. I made a number of trials at 83 periods at the works with a small Ferranti transformer, and they fully confirmed this supposition. It was not possible to get the effect if you slowly broke the current. Slow breaking, followed by rapid making, never showed more than a very slight effect. Slow breaking, followed by slow making, never showed any effect at all, nor did slow making. That is to say, if the current were made to decrease slowly at breaking, or to increase slowly at making, the effect was avoided, you would think the resistance switch would be scarcely making slowly sufficient to make the current go in the other way. Dr. Fleming said that if the transformer were put on backwards, that is to say, if they were magnetised through the secondary instead of through the primary, this effect ought not to occur. Well, I made some experiments, and found it did occur, if the current were made through the secondary rapidly. But the real reason why it does not occur under ordinary circumstances if the transformer be magnetised through the secondary in the first place is, because the resistance of the switch contacts bears a much greater proportion to the resistance of the whole thing, in the case of the secondary switch, than in closing the primary switch with a very small current. I wanted to see, if the effect penetrated to the secondary, that is to say, whether a wave of current or a wave of magnetism, whether a large wave of current set up a large wave of magnetism. I put a 16 C.P. lamp on the secondary and found no such effect. Whether a rush occurred in making the primary circuit, or not, the secondary lamp always glowed with the same incandescence, showing that although we got a rush of current, scores of times greater than the normal going into the transformer with the first wave, it did not penetrate through the transformer to the secondary. Therefore there is not a large wave of magnetism set up in the enormous rush of current.

Mr. R. E. B. CROMPTON: The true efficiency of existing plant, worked under the best conditions, and continuous, would be $\frac{3}{14}$ths of a lb. of coal, whereas the best results we have got are $\frac{3}{4}$ths for the alternating machinery. We now know it takes $\frac{6}{10}$ths, and whereas in one case there are only $\frac{3}{14}$ths of a lb. of coal to be accounted for on account of low load efficiency, or want of efficiency rather; in the other case there are $\frac{13}{10}$ths, or 13·2 of a lb. of coal still remaining to be accounted for. Now I believe it would be found that nearly $\frac{3}{4}$rds of this does go still in transformers. That is, of course, pure guess; but if we apply the knowledge we have on the load factors of private houses to the very best transformer that has been described in this paper, the Westinghouse and Mr. Mordey's, we shall find that, with the ordinary load factor of a residence in London, they would work out at an efficiency, Mr. Mordey's 45·5 per cent., and the Westinghouse 54·5 per cent., and that if they were transferred from that division to that of a private house having its own tranformer, to the position of being grouped at certain feed points on a sub-station principle, as contemplated in my other paper, the load factor would be altered to a point midway between that and the station. Now we know the best stations vary in residential districts from 10 to 12 up to 14, whereas on private houses there are about 2 or 3. It follows according to the number of transformer station, so will the load factor of the transformer at the sub-stations approach one or other of those figures, that is to say, if there is a very small number of transformer sub-stations, the load factor might be nearly approached that station itself up to 14, whereas, on the other hand, if, as proposed by Mr. Kapp, Mr. Preece and others, to make your transformer points very close together, having a very light low pressure network, then the load factor at each of those points would nearly approach that of the houses, and may be as low as 5 per cent.; but if I take it at 7 per cent., according to the Westinghouse figures, given in Dr. Fleming's paper, it gives 80 per cent., almost efficiency, so that really we have come to this point, if we use the best transformer in the way proposed by the best engineers who are advocates of alternating distribution, we should be able to bring up the existing efficiency of stations to distribution efficiency from 50 per cent. to 80·7 per cent., and that is a very great gain.

THE PACIFIC OCEAN CABLE.

From the Documents contained in the Report presented to the two Houses of Parliament by the Postal and Telegraphic Departments of Victoria, for the Year 1891.

GREAT BRITAIN has not participated in the payment of a subsidy granted to the Eastern Extension for their cables which join Australia to the United Kingdom. Why the home Government has thought it necessary to have this subsidy entirely in the hands of the colonies is not apparent. The maintenance and improvement of the telegraphic communication which joins their great possessions together is naturally as much in the interest of the Government as of the colonies.

As to the survey for the laying of a cable in the Pacific Ocean, there was scarcely hope for its being carried out in the face of the opposition which the British Admiralty had already put in the way of a similar request, formerly made to them by the deputies of the Conference of Colonial Governments. This decision is, perhaps, to be regretted, as some new soundings would certainly have caused many of the prejudices, actually existing against the enterprise of laying a cable across the Pacific, to disappear. We have not been able to learn anything of the official reports on the investigations of the ocean made by the American (*sic*) ships *Challenger* and *Tuscarora*; and the opinions expressed at the above-mentioned conferences on the results of their operations are so contradictory that a definite opinion on this point cannot be formed. If, on the one hand, the officers of the United States Navy have not concealed the existence of certain

obstacles in the way of the laying of a Pacific cable, they have not, on the other, declared and pointed out its impossibility. The adversaries of the project may, perhaps, have slightly multiplied in their imaginations the number of coral reefs and rocks at the bottom of the Pacific Ocean.

Detailed accounts of the negotiations which took place for the extension of the international telegraphic communication of Australia and the fall of the tariffs on the existing lines have already been published. This is but a retrospective view of the efforts which have been made to realise the project of a Telegraphic Union between Australia and America across the Pacific Ocean since the year 1871 up till to-day, when the question seems to have entered into a more happy phase. After the conclusion of the new arrangement between the Eastern Extension Company and the Australian Colonies for the lowering of the International tariffs, the realisation of the project for laying the cable across the Pacific Ocean had become very doubtful. In Australia, the Government of Queensland was the only one which had remained faithful to the project, and that of New South Wales had also retained some sympathy for it. Canada had also remained favourable to it, but the union of these three Governments was not sufficiently powerful to accomplish so vast an enterprise. The Pacific Telegraph Company, Limited, discouraged, probably, by these successive checks, gave up trying to achieve its purpose; but its principal representative, Mr. Audley Coote, did not consider himself beaten. While continuing the struggle with the tenacity so well known in the Anglo-Saxon race, he at last succeeded in securing a powerful auxiliary. He entered into negotiations in France, where the Government, who had for some time past desired to possess telegraphic communication with New Caledonia, received his proposals favourably, and granted him a concession and a guarantee of interest for the laying and working of a cable between New Caledonia and the Coast of the Colony of Queensland. In order to realise the necessary funds for the execution of the enterprise, Mr. Audley Coote had, after long negotiations, obtained the assistance of a body of capitalists who founded a company in Paris under the name of "Compagnie du Télégraphe de l'Ocean Pacifique," with a capital of 50,000,000 fr. (= £2,083,333); and, afterwards, the "Société Française des Télégraphes Sous-marins" amalgamated with them for this special purpose. The new company undertook to provide the necessary funds, and to lay the first section of the Pacific cable—that is, from Queensland to New Caledonia—on condition that the Governments interested in the matter should grant them, collectively, a guarantee of an annual revenue of 300,000 fr. (= £12,500), for a period of 30 years.

The French Government having agreed to this condition by undertaking to contribute 200,000 fr. (= £8,333 6s. 8d.) to this "guarantee" or "subsidy" fund, Mr. Audley Coote made a proposition to the Government of Queensland to complete the subsidy in conjunction with the colony of New South Wales, under the following conditions:—

During the whole time of the guarantee the Governments of Queensland and New South Wales should have the free use of the first section of the Pacific Ocean cable for the transmission of their official telegrams up to the amount of their annual subsidy. The minimum charge for a telegram of ten words sent between Queensland and New Caledonia should be fixed at 7s. (8 fr. 75 c.), of which 6s. should be for the cable and 1s. for Queensland; for every additional word there should be a charge of 70 centimes (= 7d.), upon which the company should receive 60 *centimes* (= 6d.), and Queensland 10 *centimes* (= 1d.) A telegram of 10 words, or less, for New South Wales, should cost 8s., to be divided as above, of which 1s. should be for this last colony.

The post office of Queensland should receive, besides this, 10 *centimes* for every word on all telegrams sent by their lines, whether coming from or going to the new cable.

Besides this, as soon as the principal cable of the Pacific Ocean should have been laid, the guarantee then existing should be reorganised, and should form part of the collective subsidy of all the colonies that might participate in a guarantee for the great Pacific cable.

The annual expenditure for the working of the cable should not exceed 60,000 fr. (£2,500); it is understood that the products of the traffic should, in the first instance, go to defray the expenses, and that all excess of receipts, over and above expenses, will be applied to the reduction of the annual guarantee of 300,000 frs. (£12,500) granted by the Governments of the French Republic, Queensland and New South Wales, and should be divided amongst them in the proportions stated below:—

The French Government ...	200,000 frs.	[£8,333]
New South Wales	50,000 „	[2,083 5s.]
Queensland	50,000 „	

The company should undertake to maintain the cable in good working order, and in the case of its being interrupted for a period exceeding 21 days, the payment of the guarantee should be suspended until communication is again completely restored.

Mr. Audley Coote was also authorised by the Société Française des Télégraphes Sous-marins to declare that they undertook to construct and lay, in a period of eight months from the date of the signing the contract, a cable to establish telegraphic communication between the coasts of Queensland and New Caledonia, on the condition that this period should be prolonged, if, after the shipment of the cable, the Société Française des Télégraphs should not succeed in laying the cable, owing to an accident, or any other unavoidable cause.

Whilst making these propositions, Mr. Audley Coote added, that, as he had for several years been trying to realise the project of establishing a telegraphic cable across the Pacific, and knowing how much the Government of Queensland desired to make certain of this communication, he had made overtures to this effect with the Government of Hawai, with the result that, in the year 1887, he had obtained the right to land one or more cables on the islands of Hawai, and in addition to this the promise of an annual subsidy of 125,000 frs. (= £2,508 6s. 8d.) for a period of 15 years, in virtue of a law passed by the parliament of that kingdom.

In the year 1884 the Government of Samoa had also granted him a concession for the landing and working of cables on the coasts of their archipelago for a period of 21 years.

In a letter, dated February 25th, 1892, the Government of Queensland informed Mr. Audley Coote that they accepted the proposition of the Société Française des Télégraphes Sous-marins for laying and maintaining a cable between Queensland and Caledonia, on the conditions expressed in Mr. Coote's letters of February 19th, 20th and 22nd, and that they were ready to conclude such an arrangement with him, as soon as a similar understanding had been arrived at with the Government of New South Wales. Before coming to a definite decision, this latter government desired to make certain that the Société Française would proceed as promptly as possible with the laying of the cables between the Fiji Island and Samoa, that is, after the Queensland-New Caledonian cable had been laid. The Société having immediately assured them on this point, with the understanding that Mr. Audley Coote should be able to obtain a subsidy for this new cable from the interested States, New South Wales also declared, on March 18th, 1892, her acceptance of the proposition made by Mr. Audley Coote in the name of the companies which he represented.

It is stated that, at the present time, definite arrangements for the laying of the cable from Queensland, and for prolonging it as far as the Islands of Samoa and Hawai, have been concluded, and that the machinery of the Société Française des Télégraphes Sous-marins is already actively at work on the manufacture of the cables destined for the execution of the enterprise.

Once the Pacific Ocean cable has been laid as far as the Hawai Islands, the completion of its last section as far as the Island of Vancouver will not be very distant, as the Canadians are impatient to see it carried out.

So now it is hoped that the daring conception of Mr. Cyrus Field, the great genius of submarine telegraphic enterprise, will soon be realised, a consummation, in the cause of science and the progress of humanity, long hoped for. But it must not be forgotten to say that its completion will be due to the energy and perseverance of Mr. Audley Coote.

ABSTRACTS OF PUBLISHED SPECIFICATIONS, 1891.

The Price of all Specifications (old and new) is now 8d. each.

8,845. "Improvements in galvanic batteries." R. HADDAN. (A communication from abroad by I. Cabanyes, of Paris.) Dated May 25th. The outer case or cell is preferably composed of two cases of wood, one within the other, a slight space being left between the two which is filled with melted paraffin, the wood being also coated with paraffin. The carbon electrode is composed of a number of prismatic carbon rods, grouped together in a cylindrical or prismatic figure, their upper ends being connected by, and fixed to, a copper connecting ring. A suitable number, preferably four, of these groups are connected together to form one electrode. The zinc rods are separately connected by suitable clips to cross rods, preferably also of zinc, supported upon a frame of wood, so that any zinc rod may be at any time removed and replaced without interrupting the working of the battery, or all the rods may be drawn up out of the solution in the known manner when the battery is not in use. The zinc rods dip into porous jars placed within each group of carbons respectively. The solution for the carbons in the outer case or jar consists of a mixture of equal parts of nitric acid and hydrochloric acid mixed together, and to which is added an equal quantity of water acidulated with 5 per cent. of sulphuric acid. The depolarising solution consists of a solution of chloride of sodium. 1 claim.

8,963. "Improvements in the method of wiring for electric lighting and other purposes." W. B. SISLING, W. H. SCOTT, and LAURENCE, SCOTT & CO., LTD. Dated May 27th. In one arrangement the inventors have a shallow metal trough just large enough to hold the wire or cable, and they place over this a similar trough fitting tightly over the first trough, and the whole may be secured, when necessary, by means of saddles, staples, or other convenient means. In another arrangement the first trough containing the wires or cables may be covered by a tightly-fitting flanged trough cover, which may be secured in position by pins or screws inserted through holes in the flanges into the supporting wall, or the like, along which the wires are run. 1 claim.

9,249. "Improvements in electro-magnets for holding tools, lamps, brackets or other articles, and for telegraphic and other apparatus." F. J. ROWAN and W. MCWHIRTER. Dated June 1. The inventors have a soft iron core with an electric exciting coil wound upon it, and having fixed at one end an iron plate or yoke, which may be part of the apparatus to be supported. To the plate or yoke they fix an iron cylinder enclosing the electric coil, which cylinder may be shorter than the core, and may have a portion of its outer rim cut away, so as to concentrate the magnetic action at one part. 1 claim.

9,261. "Improvements in reciprocating electric motors." H.

PIEPER FILS. Dated June 17th. Consists in an electro-magnet, an armature being under the influence of both poles of the former, and a coil surrounding the armature and located in one of the magnetic fields formed between the armature and the electro-magnet. 3 claims.

10,612. "Electrical transformers for rotary-phase currents." SIEMENS BROTHERS & CO., LTD. (Communicated from abroad by Messrs. Siemens and Halske, of Berlin.) Dated June 22nd. The several limbs of the core, which, as in ordinary transformers, can be formed of a number of superposed thin plates, are all arranged parallel to each other, so that their imaginary magnetic axes form the edges of a prism, and the completion of the magnetic circuit at the two ends of the said prism is effected by two precisely similar star, ring, or otherwise suitably shaped iron pieces. 1 claim.

12,107. "Improvements in drops or suspending mechanism for electric light and other like fittings." W. E. Dow. Dated July 16th. This improved drop is composed of a hollow roller closed at its opposite ends, an axial spindle that extends loosely through and projects from the opposite ends of the roller, a ratchet on one end of the spindle, supports, one for each projected end of the spindle, and both supports and projected spindle ends relatively constructed for engagement with, and disengagement from, each other, and in engagement to hold the spindle against turning while the roller is free to turn on the spindle, a spiral spring within and surrounding the axial spindle of the roller and at its opposite ends attached to the spindle and the roller, respectively, and a gravity or other suitable pawl pivoted and in position on one end of the roller to be engaged with, and by centrifugal force resulting from, the rotation of the roller held out of engagement with said ratchet of the spindle in combination with a cord or cords, or such like, suitably held on the roller immediately of its length, and otherwise, so as to present two end portions to be wound on, the one toward one end and the other toward the other end of the roller, and wound to present end portions, one extending from one side and the other extending from the other side of the roller, but in opposite directions. 3 claims.

19,965. "Improvements in and relating to conduits for electric conductors." J. C. LOVE. Dated November 17th. Relates to improvements in underground conduits for electric conductors, and to means for supporting the conductors within such conduits. 7 claims.

22,037. "Improvements in printing telegraph receiving instruments." H. H. LAKE. (Communicated from abroad by J. E. Wright, of New York.) Dated December 16th. The main object of the invention is to relieve the electro-magnets which are operated by, or connected with, the main line, of as much load or work as possible, which object is accomplished by the use of a suitable motive power independent of the magnets for effecting the mechanical operation of the several parts of the printing and feed mechanism, and by utilising the electro-magnets merely for releasing, arresting, and generally for controlling the action or operation of the said motive power. 19 claims.

DISCUSSION ON ELECTRIC TRACTION SYSTEMS.

THE series system of electric traction has again become the subject of discussion in America, and Mr. Nelson Perry, who is the exponent of the latest application, has introduced some novelty; but the tramway manager will no doubt feel that though his system offers apparent advantages, yet obvious drawbacks may more than counterbalance them. In theory, the series system is simple, and in Mr. Perry's modification, the method of "feeding in volts from separate generators, easily comparable to the feeding in of the ampère in the parallel system," is ingenious. "By this means," says Mr. Perry "the voltage at the generator is kept within the capacity of the dynamo, just as in the other system the current is kept within limits." It is not quite clear how the volts are fed, and we should like to see the method thoroughly explained before passing an opinion on it. Dr. Hutchinson and various other American engineers with large tramway experience, have criticised the scheme in no sparing terms, and we are practically in accord with the objections stated by the various speakers at a recent discussion of the railway papers before the American Institution of Electrical Engineers (see the *Electrical World* of New York, November 19th). And the consensus of opinion seems to be that the series system of electric propulsion is played out, and certainly the few attempts in England and America have invariably failed.

It may serve some useful purpose if we detail a few of the advantages and disadvantages of the series system. The advantages may be summed up as follows:—

1. A saving in line copper, since the current can be made small if there be no objections to a high pressure.

2. Since the current is constant, it is impossible to burn out the motor from overloading.

3. The machine can be used either as a dynamo or a motor by reversing the positions of the brushes.

4. The tongue on the motor can be varied within limits by shifting the brushes or by commutating the field windings.

The disadvantages are perhaps of greater moment, as will appear from the subjoined remarks:—

1. Since the current is fixed, the maximum torque on the motor is simply determined by the size of the machine, and therefore in order to ensure the initial starting power, both the field magnets and the armature have to be far heavier than would be required in a parallel system.

2. It is not feasible in practice to run two series motors in series with each other (as is sometimes done in parallel tramcar work), without automatic governors to each. For should the roads be at all greasy, one pair of wheels may slip, and hence, although the two machines will be taking the same current, yet one may be racing while the other is stationary. (This objection is equally applicable to coupling the two motors on a car in series on a parallel system; in fact, the two motors are generally run in parallel, or one machine is cut out of circuit. In the series system, it must be borne in mind, the motors are necessarily in series.)

3. If there be more than one car on any section of the line, the one meeting with the greatest resistance will stop, while that with the lighter load will absorb the whole of the voltage. (This is considered by the exponents of the series system as an advantage, for it forms a kind of block system.)

During the discussion, reference was also made to the use of shunt-wound motors for tramcar work, and Mr. Sprague gave it as his opinion that, in spite of the many difficulties in the way, it was very probable that the shunt method would ultimately be applied to many lines of street car service, because of the inherent regulation of speed, and power of braking the car and giving energy to the central station when descending grades. This is a point which has not escaped the notice of electricians, but yet the practical difficulties in the way of the high tension shunt motor have prevented street railway managers from using the shunt machine. But now so many of the troubles peculiar to this class of work have been successfully overcome, the attention of engineers must necessarily be directed more to economy of working, and the coal bill will soon be the only commercial criterion, as it is already in the central lighting station.

That system which gives the most economical results, other things being equal, must inevitably supersede all others.

The steep peaks shown in load diagrams have already received attention, and Mr. Mailloux's scheme for using accumulators to give the momentary excess energy at these points must be seriously considered before long. The objection to it, simply on the ground of the use of a battery, is no longer tenable, for Planté plates properly selected for the work would undeniably last for years, and cost far less for maintenance than the interest on the capital saved by the use of the battery.

Mr. Ward Leonard's series system with a dynamotor on each car was also treated with some severe criticism, and since it can claim a hearing only on theoretical bases at present, we are not surprised at the strictures. Undoubtedly the complication involved seems by no means a step in the right direction, but *experientia docet*, and Mr. Leonard says the system is soon to be put in practice.

Its chief point is an attempt to vary the E.M.F. of supply, whilst maintaining the primary current constant. This is tantamount to varying the voltage to suit the car speed, and marks an apparent step in advance of all other systems. The weak point, perhaps, is to be found in the multiplication of the moving parts, and in the three machines required to equip each car.

A variable speed ratio gear was of course on the tapis, but did not secure much attention; in fact, one speaker doubted whether, at the present stage of the arts of mechanics, it was worth while seriously discussing it. Mr. Leonard Ward's system offers a fair approximation to it in theory, at any rate, and if his expectations are realised in practice, street railway work may see some very important modifications during the next few years.

As a whole, the discussion seems to have been very animated, and of a thoroughly business character, all the speakers being men of large experience in traction work, and in close touch with the practical requirements of the tramway manager, and the present capabilities of the electric systems.

CORRESPONDENCE.

Electric Lighting at Brescia.

In a recent number of your paper appeared an article headed, "The Electric Lighting at Brescia," which was communicated to me by some English friends who intended to send in a tender for this enterprise, but were rather frightened by the assertions it contained. My friends asked my advice on the matter, knowing that I knew Brescia and the people there very well, having built there, some years ago, the telephone exchange, and been thus in constant contact with the authorities of the town as well as with those of the Government.

In reading the said article, I was surprised at the singular way your "special correspondent" looked at the whole matter, but more so when I saw how freely he translated certain passages of the conditons, leaving directly out what seems not to have agreed with him, &c. For instance, he writes in italics, that the contractor must not only oppose no difficulties to the local authorities, if they wanted to make experiments on a new system of electric lighting, but he must also supply the apparatus which the authorities might demand. Now this sounds indeed very absurd, but fortunately the regulations say that the contractor has only to supply such apparatus which he has in his plant, not that he has to provide whatever the fancy of the authorities might prescribe. This clause is certainly a very wise one, and if we combine it with others, which say that for every extraordinary demand of current, the authorities will pay in proportion to the established tariff, I fail to see what terrible consequences this paragraph could involve.

I think it to be my duty, to say, that as far as I have experienced the ways and manners of the people and authorities of Brescia, I have always found them to be most straightforward and gentlemanly in their dealings, not at all "chicaneurs" but very much the contrary, and I could only wish that all local authorities in this world might be as favourably disposed towards those who bring progress into their towns, as the authorities of Brescia were when the Société Telefonica Brescia, of which I was then the Chief Engineer, started the exchange.

Speaking from my own experience, I can only most heartily encourage British electricians to compete in this enterprise, and I feel it to be a duty of your paper to destroy the discouraging effect that this article, which was decidedly based upon a complete misunderstanding of the situation, and, perhaps, of the Italian language, has produced, and to encourage British enterprise on the Continent.

Hoping you will favour me by inserting these lines in your paper, and give me and yourself the opportunity to do justice to a small, but intelligent and go-ahead population, I remain,

Dr. A. von Wurstemberger.

Berne, *December 27th*, 1892.

High Pressure Steam Generators.

I am sorry to see Mr. Thwaites is getting cross, and that he tries to raise a laugh against me in reference to the dishing of the ends of Lancashire boilers, a suggestion which, says he, will make practical boiler makers laugh.

Now, I have made boilers in England; I have made them in Oceana, and I have made them in America, and know of what I am talking, and would suggest that if Mr. Thwaite wants to learn he should go to Messrs. Leigh, the cotton spinners of Stockport, and ask them to show him the two old boilers, if still there, at their Beehive Mill. After that he may go to Messrs. Mellor's cotton mills on the Irwell side, near Bury, and ask to see, or for a description, of their dish-ended Lancashire boilers; or he might ask Messrs. Wright, of Tipton, who made these boilers, and he would then learn, first, how he might connect internal flues to such ends; and, secondly, that your critic did not write in ignorance. I am sorry my anonymity is distasteful to Mr. Thwaite. I have at least given him a very good indication of one source of my boiler experience, but he so italicises two of my words in his later reply, that he plainly shows he believes I am exaggerating, or doing worse, whereas I am merely giving an indication to everyone who has a wide experience in steam boilers.

In his anxiety to raise up objections to existing types, I think Mr. Thwaite meets difficulties half-way. The demand for strength made possible the corrugated and ribbed furnace, one of which forms, at least, had been invented 40 years before a sufficient demand made the manufacture a commercial success. Possibly we have not yet seen the end of the idea of rolling shell plates as rings. Tyres were once welded, and when they were rolled solid, the achievement was far greater than would to-day be the rolling of a boiler plate of ring form, so as to dispense with rivets. How much heavier need a shell of 8 feet be than two of 4 feet diameter for equal pressure, and half capacity?

As an American engineer myself, I will not enter into a portion of Mr. Thwaite's letter, further than to say that corridor cars are not American, that English railway mismanagement is not a question of engineers at all, but the outcome of the Forbes-Watkin element, which so unfortunately controls English lines, and for which this American engineer, had he the power, would find a remedy to-morrow.

Now, in conclusion, I have no wish to pose, as Mr. Thwaite *unscrupulously* hints, as in any way a superior person, but when, as in his earlier reply, Mr. Twaite denies me either education or experience, I would remind him that he had no right to do this, seeeng that I am anonymous, and cannot, therefore, flaunt my name and prove my right to criticise or discuss questions of steam engineering. I merely wish to add that steam boiler furnaces, entirely in refractory material, are not new, nor is their adoption limited to any special form of boiler. I will not retrace the original criticism. There are men in the North of England handy to Mr. Thwaite to whom he can explain his boilers, and perhaps obtain opinions as to their suitability for general practice, to which he will, perhaps, pay more attention than he is inclined to give to

Your Critic.

P.S.—An empirical formula, even if in Molesworth, is not a *proof* of anything; it is at most a figurative expression of the opinion of its compiler upon the subject dealt with, but proof of nothing.

Twenty Years' Telegraphy in India.

Your journal being very generally read by telegraph men in India, much surprise was caused by the article with above heading in your issue of August 12th, in which credit is given to Sir A. Cappel for the introduction of the half-rupee tariff for *deferred* telegrams, which tariff, as you correctly observe, has so largely conduced to the immense increase in revenue.

This measure, however, was introduced not nine but eleven years ago, and not by Sir A. Cappel, who was absent from India at the time, but by his predecessor, Major General R Murray.

G. T. D.

Automatic Railway Signalling.

Referring to your notice of December 30th, of the signals of the Automatic Electric Railway Signal Company, Limited, will you allow me to say, through your columns, that it was never for a moment supposed, let alone claimed, that the system of signals owned by the above-named company would entirely dispense with the "control of a human agency responsible to its due and efficient action." The discoverer of such a system, might, in a very brief period, be expected to solve the problem of "perpetual motion." A considerable saving, however, is claimed for the company's system, in addition to increased safety.

I may add, that automatic electric signals are now being placed upon the Liverpool Overhead Railway.

J. Harvey Evans,
Secretary, Automatic Electric Railway Signalling Company, Limited.

January 2nd, 1893.